NATURE

No. 4199 SATURDAY, APRIL 22, 1950 Vol. 165

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Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831
Telegrams: Phusis Lesquare London
Advertisements only should be addressed to:
J. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2
Telephone Number: Temple Bar 1942
The annual subscription rate is £4 10 0, payable in advance, inland or Abroad

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UNIVERSITY DEVELOPMENT

SINCE the end of the Second World War, there has been much discussion of the physical expansion of the universities of Great Britain, and also of the functions they should perform. More recently, of course, the position of technological studies has been much to the fore; but that question is only one side—although a highly important one—of the wider problem of their position in the educational system of the country. In such a discussion, much can often be learned from the experience of other countries; and in this connexion a study by Dr. Frederic Lilge of the history and growth of the German universities during the nineteenth century under the title "The Abuse of Learning: the Failure of the German University"*, which has recently become available in Great Britain, provides a number of points for consideration.

Dr. Lilge's study was undertaken to determine the reasons for the failure of the German universities to offer any effective resistance to the Nazi regime in Germany. From this particular point of view, it should be supplemented by E. V. Hartshorne's "The German Universities and National Socialism", or the analysis of the Nazi university in A. S. Nash's "The University and the Modern World". The soundness of Dr. Lilge's conclusions in general, however, is indicated by the extent to which the changes recommended in the recent German Commission's report on university reform in Germany (see *Nature*, **163**, 552; 1949) are designed to eliminate exactly the weaknesses to which his book directs attention. The book is highly relevant to at least three aspects of the discussion on university problems in Great Britain: the balance between university studies, such as science and the humanities, and between research and teaching; the place of a general or cultural education in specialist training; and the relation of professional and technological training to university education. It has also a bearing on the relations between the universities and the State which, in view of the growing dependence of the universities on the State for financial aid, cannot be regarded as static in Great Britain.

The opening chapter of Dr. Lilge's book describes the brief flowering of German humanism, and the contribution of Humboldt and the influence of Schleiermacher, Ranke and Hegel. This chapter is perhaps the most pertinent in considering the relations between the universities and the State in Great Britain. The first basic German inquiry into the political conditions necessary for free association and for respecting individual freedom inspired John Stuart Mill in writing his famous essay a century ago, and in his essays Humboldt anticipated certain dangers which threaten science and scholarship in this century as well as in the nineteenth century; though he was more concerned with the lack of freedom which prevented the liberal university from coming into existence. Humboldt and Schleiermacher saw the task of the 'liberal' in government as first to teach

* The Abuse of Learning: the Failure of the German University. By Frederic Lilge. Pp. vii+184. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1948.) 21s. net.

respect and understanding of the nature of intellectual work, and ultimately, perhaps, to establish a republic of learning within the boundaries of the national State; they believed that the universities could not become institutions of liberal education unless the State relinquished its demands for the immediate usefulness of science and learning. Nevertheless, in spite of Humboldt's reforms, the fortunes of the German universities continued to depend upon the goodwill and the favour of governments. Humboldt himself conceded to the government an interest in the appointment of professors, and in reality the German university remained an institution in which the great majority of students prepared for the professions of medicine, law and theology, just as they had done in the medieval universities of Europe. It was Ranke, together with such scholars as Niebuhr, Savigny and Böckh, who helped to transform the universities into research institutes, in which the teaching and study of the humanities as Humboldt had defined them fell into neglect. Dr. Lilge shows that there was a sharp break with the educational ideals of Humboldt and Fichte, and that a fundamental cause of the break lay in not adjusting university teaching and the organisation of knowledge and of courses so as to compensate for the increasing specialization and absorption in research.

Research, in fact, dominated teaching, and Dr. Lilge emphasizes this point in a later chapter in which, following one devoted to a critical review of Fichte's idealistic conception of a university, he deals with the growth and progress of modern science. Liebig began to introduce university students to the methods of scientific research; but the apparent contempt of the German idealists for the scientific method was one important factor provoking the fatal schism to which, in the main, Dr. Lilge attributes the easy capitulation of the universities to Nazism. In this he is largely supported by Dr. Hartshorne, who stressed also the deep-rooted sense of the futility of intellectual activity and of the bankruptcy of the German Christian cultural tradition which pervaded academic circles.

The danger was recognized by a few men of science such as Helmholtz, A. W. Hofmann and Lothar Meyer, who saw in this division the beginning both of the isolation between the different branches of knowledge and of the dissolution of the university into narrowly specialized professional and technical schools against which Fichte set his face. The development of the technical high schools from 1860 onwards did nothing to check the process, in spite of the warnings from Helmholtz and Hofmann as to the dangers of unvaried and highly specialized research, both to the imagination and to a young man's general grasp of the field. The manifest material benefits to society which scientific research was beginning to yield led to the deficiencies of research as a method of education being brushed aside; a conception of the university very foreign to the ideas of Fichte concerning the organisation of knowledge and the methods of study and teaching gained the field. This aspect is very pertinent to the discussion of educational problems to-day.

In later chapters, Dr. Lilge deals with the criticism and satire of academic culture by Nietzsche and others, and with the growth of modern irrationalism and Fascist mythology, presenting a series of summaries of the thought and teaching of particular philosophers rather than a critical appraisal. Nevertheless, in discussing the views of such men as Weber, he indicates the relevance of their thought to present discussion, the danger of separating technical power from moral responsibility, and the importance to the advance of science itself of scientific ideas having their source solely in human imagination and judgment, and the fallacy of supposing that culture can ever be radiated from a lecture room.

One striking feature brought out in the final chapter of this book is the way in which the problem of a liberal university continued to be discussed in Germany right up to the advent of National Socialism. The earlier idealist and humanistic ideas on university study had lost most of their controlling influence but not their challenge. Though the German university became more and more an institution devoted to scientific research and professional training, the idea that it should be an institution of liberal education persisted among all its major critics. Dr. Lilge does not agree with Dewey's explanation of the catastrophe of German education and culture, believing that Dewey has ignored the destructive power of the anti-rational and illiberal philosophies; and his own conclusion is that the main factor was the earlier surrender of the idea of truth as universal and indivisible.

Dr. Lilge's book is a thought-provoking one, and part of its value may well lie in the attention redirected to the addresses of Hofmann, Helmholtz and others in the second half of the nineteenth century, in which were foreseen and discussed some of the very problems of university education and development which its post-war expansion in Great Britain has again brought to the front. Although it is a fashion to give little thought to the past history of university institutions, it may still assist us to come to right and lasting decisions if we give due consideration to the opinions of leading men of learning who themselves lived in a period when views of the functions of the universities were changing rapidly.

VARIETIES OF PRIMITIVE RELIGIOUS EXPERIENCE

Forgotten Religions (including some Living Primitive Religions)

Edited by Prof. Vergilius Ferm. Pp. xv+392. (New York: Philosophical Library, Inc., 1950.) 7.50 dollars.

THIS is an ambitious symposium, produced for the most part by American scholars, and revolving around the general subject indicated with rough and approximate accuracy by the title. It has the characteristic defects of the symposium—scrappiness, discontinuity and an irritating diversity of methods of treatment and styles—but on the whole the book can be warmly recommended. It covers

the early riverine civilizations of Egypt and Sumeria, the non-Hebraic semitic religions, the earlier cults of the classical Mediterranean peoples, as well as the later mystery religions, late Persian developments like Manichæism, the ancient Norse mythology, Tibet and some of the more primitive religions found among the Australian aborigines, the North American Indians and the Eskimos. Of course, there are bad gaps, for example, pre-Confucian China; but selection there had to be, and with any selection whatever it would be possible for a carping critic to pick a plausible quarrel.

The individual essays vary not only in quality and value but also in length and profundity of treatment. Some of them provide no more than the briefest and most elementary descriptive accounts of their subject, while others give space to the interpretation of their theme and the elucidation of some still relevant message to living men; nor is it possible to discern any overruling editorial plan behind this unequal distribution of concentration and space. Thus the longest essays are devoted to Hittite religion (thirty pages), the Canaanites (thirty-four pages) and the Eskimos (thirty-two pages). These lengthier essays may be contrasted with the much briefer treatment accorded to Manichæism (ten pages) and Sumerian religion (sixteen pages). Clearly there can be no balanced and calculated planning here. Nevertheless, some of these essays are really quite first rate—especial thanks are due to Dr. Mylonas for his discussion of the Greek mystery religions and to Dr. Mercer for twenty-two brilliant pages on the ancient Egyptians—and none falls below the level of a rather elementary and uninspired trustworthiness and competence.

The editor allows himself no more than a few pages of modest preface; but they are really quite excellent and leave the reader wishing that he had spread himself more generously. So many discussions of religious phenomena suffer from the embarrassed desire of the investigator not to commit himself one way or the other as to the general validity of the kind of activities with which he is concerned. He tries to discuss a response without alluding to the stimulus, without even making it quite clear whether or not, in his view, there is any stimulus. Dr. Vergilius Ferm is clearer about the foundations and presuppositions of comparative religious studies. Religion is found, in both actual and potential forms and phases, among all peoples at all times and in all places, because it is "the most natural thing in the world", because it expresses something inherent in man and responds to something inherent in the nature of the universe. In view of the universality of religious phenomena, to suppose the contrary is surely to suppose the unlikely and improbable. Without some such presupposition, the student of comparative religion finds himself rather in the position of a psychologist trying to write about the instinct of hunger without committing himself as to the existence and biological necessity of food.

Nevertheless, once we have got beyond the initial affirmation that in all religion we have a genuine and psychologically valid and necessary adaptation to a real environment, we find ourselves confronted with the bewildering variety of actual religious phenomena, for the adaptations may differ profoundly in manner and effectiveness. The variety is so great indeed that all attempts to produce a watertight definition of the term religion have so far broken down. If we attempt to define it as a specific kind of belief, say in gods or spirits, we find ourselves confronted with veritable religions which ignore or deny the existence of such beings; if, on the other hand, we attempt to define it in terms of specific ritual practices, our attention is attracted to forms of religious behaviour from which the cultic element is lacking. The place of personal insight in religious development, and the creative role of the great prophets and religious reformers, refute any attempt to define religion exclusively in terms of social conformity and conditioning; but the reality of the ethnic and corporate aspects of religious belief and behaviour make it equally impossible to comprehend the essence of the thing in purely individualistic and mystical terms. There is, in fact, no reigning and ruling definition of what constitutes the religious phenomenon—only a not wholly unfounded and not wholly misleading 'hunch' that we all know how to recognize the religious when we see it—and a book like this, which sets so many descriptions of so many varieties side by side, prompts the reader to question whether there ever will be.

J. V. Langmead Casserley

TEXT-BOOK AND ENCYCLOPÆDIA OF PHARMACY

Remington's Practice of Pharmacy

A Treatise on the Making, Standardizing and Dispensing of Official, Unofficial and Extemporaneous Pharmaceutical Preparations, with Descriptions of Medicinal Substances, their Properties, Uses and Doses. Ninth edition, by Dr. E. Fullerton Cook and Eric W. Martin. Pp. xi+1511. (Easton, Pa.: Mack Publishing Co.; London: Interscience Publishers, Ltd., 1948.) 16 dollars.

THE ninth edition of "Remington's Practice of Pharmacy" is described in the preface as a students' text-book and as an encyclopædia of pharmaceutical information. To assess an American text-book in terms of British requirements is to remove the book from its context. However, it cannot be considered an advanced text-book. The size is due partly to frankly encyclopædic material, and partly to the inclusion of subjects usually dealt with in separate text-books, together with what seems an unnecessarily large amount of the text of the United States Pharmacopœia and the National Formulary.

The section dealing with pharmaceutical chemistry especially suffers from being too closely tied to the official monographs. Purity tests, when included in separate monographs, are difficult to learn and would be more easily understood if they were collected into groups based on the chemical nature of the impurities. The diagrams showing the structural formulæ of drugs of related chemical constitution are valuable features of the section on organic chemistry.

The chapter on sterilization is little more than an uncritical description of the United States Pharmacopœia processes. No attempt is made to explain the difference between the lethal effect of moist and dry heat or the fundamental unsoundness of applying a process of intermittent heating to non-nutrient solutions, except to say that it is not a sure method of sterilization. The detection of small numbers of injured bacterial cells in supposedly sterile medicaments is one of the difficult problems in pharma-

ceutical bacteriology; but in this book of more than 1,500 pages sterility-testing is given one page. On the other hand, the preparation of parenteral injections is described clearly and fully. This example represents the bias of the book, which is a well-written factual account of the practice of pharmacy taking the widest interpretation of that ill-defined term. To this extent the book is true to its title. The chemical, physical and biological theories on which at least part of that practice is based rarely receive more than superficial attention. Certain chapters are, however, well worth reading because of the comprehensive survey they give of their subject, such as that on comminution, or because they possess a higher quality than their companions, as that on statistics. The chapter on ointments is interesting because of its pharmacological approach to the subject.

As a pharmaceutical encyclopædia the book is much more successful. Although much of the information is of local value only, it will be valuable as a reference book to pharmacists in Great Britain and invaluable to those who may have to dispense American prescriptions. Descriptions of drugs and preparations official in the United States Pharmacopœia and National Formulary are followed by comprehensive lists of related unofficial and proprietary materials. A table of proprietary surface-active substances with their chemical characters and one which gives the solubility of dyes in various solvents should prove useful to hospital pharmacists, while the chapters on insecticides and rodenticides, dental preparations and perfumery will be of interest to those in retail practice. Glossaries of medical, pharmaceutical and technical terms are included, and there is an admirable index. The chapter on flavouring-agents might well merit the attention of those responsible for formulating the medicines dispensed in such vast quantities by British pharmacists.

The use of a two-column format and a larger page-size has made the book somewhat less unwieldy than the eighth edition. Many of the photographs, especially those of plant, are of little value, but apart from this the production of the book is excellent.

K. R. Capper

BIOLOGY IN THE INTEGRATED MEDICAL CURRICULUM

Biology

An Introduction to Medical and other Studies. By Prof. P. D. F. Murray. Pp. viii+600. (London: Macmillan and Co., Ltd., 1950.) 25*s*. net.

THIS book is not just another of the biology for the First M.B. variety; it is an attempt to face up to that difficult problem usually termed "integration of the pre-medical and pre-clinical teaching". This is not all, however, for Prof. Murray has two further objectives: first, he believes that the actual subject-matter presented should be reasonably up to date; and secondly, he remembers that there is a subject, 'biology', which is not just a mixture of botany and zoology.

To tackle these problems, Prof. Murray first sets out the basic similarities of plants and animals, and also their basic differences, by a comparison of unicellular organisms. He then deals with simple multicellular animals and plants (*Hydra*, *Spirogyra*, *Volvox*, *Fucus*). *Planaria*, the earthworm and the cockroach are then surveyed, with various diversions to consider such topics as animal classification and the relations of insects to man. *Amphioxus* and the dogfish introduce the Chordata, and then we are led to consider the problems of the evolution of land-living organisms in relation, first, to the fern and the frog, and secondly, to flowering plants and mammals.

The first half of the book is concluded with a brief, but highly significant, consideration of man as a mammal, and of his evolution. The second half is occupied by sections on histology, embryology (in some considerable detail), genetics, physiology, evolution and special forms of life such as bacteria, viruses, fungi and animal parasites.

To the question "How far has Prof. Murray gone towards achieving his several objectives?", the answer must undoubtedly be—a very considerable distance. He writes in an easy style and is not afraid of colloquial phrases or of teleological statements, so charmingly defended in his introduction.

But Prof. Murray's readability may not be without its drawbacks, for as one follows his story of life from page to page, one is carried along so easily as to be in danger of not realizing that we are reading about those aspects of biology—certainly many—which appeal to Prof. Murray.

An author is entitled to put forward his own views and to choose which topics are to be dealt with at length and which are not. But this means that the elementary students for whom he is writing will need to be reminded by their teachers that this present text is not, and, indeed, does not claim to be, a complete survey of elementary biology. Many teachers who will use this book will find their ideas of emphasis may not coincide with those of the author, and for this reason alone the book will prove as stimulating to the teacher as to the student.

There are a number of points to which attention must be given in future impressions. Some of these appear to have arisen from the fact that (to judge by the date of the author's introduction, March 1948, and the date of publication, 1950) there seems to have been such delay in publication as to make Prof. Murray's effort to be up to date unduly difficult. For example, the existence of the exo-erythrocytic form of human malaria, which had been suspected for several years, was confirmed in March 1948; and although Prof. Murray's text mentions this stage, it is unfortunate that, in the two years which have elapsed since that date, a figure of the life-cycle showing it could not have been substituted for the out-of-date one now included.

There are a few unfortunate misprints, mainly in the labelling of the figures, many of which are new; one is surprised that "opthalmic" was allowed to pass in various diagrams of the dogfish head region and "caecae" in the diagram of the cockroach.

These and other misprints will, no doubt, be corrected in the new impressions as they are called for. But this book is likely to be one which will not only run through impressions but, in the course of time, through editions; so that, by way of a constructive criticism, it might be suggested that when the time comes for a thorough revision, Prof. Murray should consider the possibility of leaving much of the description of the vertebrate types to the dissecting manuals now in existence and to devote the space so gained to the general topics on which he writes so stimulatingly.

To sum up, this volume is undoubtedly a significant contribution to biological teaching and indeed commands our admiration.

G. E. H. Foxon

WORDSWORTH'S RESPONSES TO NATURAL SCENERY

By L. C. W. BONACINA

DURING the centenary year of the death of William Wordsworth at Grasmere in Westmorland on April 23, 1850, slightly more than eighty years after his birth at Cockermouth in Cumberland, the poet's message and outlook upon life and Nature will be reviewed from many angles, and so it seems fitting that his work should be considered also in relation to scenic influences, especially from the regional or geographical point of view. This, indeed, is particularly called for in the case of one occupying a unique place in English literature as a mystical lover of Nature and identified with a most distinctive and beautiful part of England—the Lakes. Wordsworth's very position as the local interpreter of Lakeland is much enhanced by the fact he was yet no mere local figure. Apart from the universality of his theme, he travelled extensively over the British Isles and the Continent, so that a wide and varied geographical range is reflected in the poetry. Naturally, any review of this kind must begin with the Lake District before passing to other parts which the poet knew. Every one of his biographers has either stated or implied that to know Wordsworth is to understand the Lakes, and to understand the Lakes is to realize that this, on its own small scale, is a true mountain land—a fact which those who rush through the district in cars and never explore its inmost recesses can easily miss.

Capacity as a scientific geographer is revealed in the poet's celebrated prose "Guide through the District of the Lakes in the North of England", the recent revival of which has already been noted by the writer in the *Geographical Journal* (**112**, Nos. 4–6, 256; 1949). This little volume is scientific in treatment as well as deeply poetical in feeling; but obviously the reader should not expect to find the antiquities, rocks and weather described in terms of modern archæology, geology and meteorology.

Among the poems a few of the more powerful landscape pictures which either specifically refer to the Lake District or can readily be inferred to do so occur in detached pieces like *The Brothers* and *Duddon Vale*; but many are to be found in the two great books *The Prelude* and *The Excursion*. One may recall the famous passage in the first book of *The Prelude or Growth of a Poet's Mind*, wherein the author tells of his first real encounter with the fiercer elements in the mountain scenery. This was on the occasion when rowing by moonlight across Esthwaite Lake he beheld a huge black peak "as if with voluntary power instinct" slowly rear its head above a craggy ledge which until then had formed the horizon's bound. The disturbing psychological effects of this startling apparition are fully narrated, and it is made quite clear that the boy recognized in the experience a token of Deity.

In the eighth book of the same great poem we find a most characteristic reaction of Wordsworth's to that stormy mountain wilderness which he knew and loved so well, in the passage where he turns to his native hills, as follows:

> "Yet hail to you
> Moors, mountains, headlands, and ye hollow vales,
> Ye long deep channels for the Atlantic's voice,
> Powers of my native region! Ye that seize
> The heart with firmer grasp! Your snows and streams
> Ungovernable, and your terrifying winds,
> That howl so dismally for him who treads
> Companionless your awful solitudes!
> There, 'tis the shepherd's task the winter long
> To wait upon the storms: of their approach
> Sagacious, . . ."

This, like so many of Wordsworth's landscape pictures, is not a particular but a generalized scene—a quality which makes it the more effective in expressing regional consciousness. Another passage in the second book of *The Excursion* records with the most delicate artistic skill how eye and ear note harmony in the response of twin peaks which peer into a secluded upland vale (believed to typify the Langdale Pikes) to storms, clouds and mists, and to light of sun, moon and stars.

There is a mountain on the confines of the Lake District, a stormy eminence close to the Cumberland coast, named Black Comb, commanding far-reaching views in clear weather, to which in the "Poems" a special degree of geographical interest is attached. It is told in *Inscriptions* how a "geographical labourer" or, as we should say, a surveyor, dwelling on the summit of Black Comb in a canvas tent with books and instruments for measuring heights and distances, recorded a sudden darkness "unthreatened, unproclaimed", total gloom in which he sat upon the "blinded mountain's silent top".

> "To him was given
> Full many a glimpse (but sparingly bestowed
> On timid man) of Nature's processes
> Upon the exalted hills . . ."

Elsewhere, in the "Itinerary Poems of 1833", it is told that shepherds ranging the heights of Black Comb or Scawfell sometimes see the clouds over the Isle of Man taking up the individual shapes of the mountains beneath them. This effect is actually well known both to meteorologists and to landscape painters, and was often rendered by Turner and Constable. The latter never felt at ease among mountains, and was far happier in the flat genial landscapes of his own East Anglia; but when he did visit the Lakes the more intimate connexion between land forms and clouds there than in the plains was one of the first things which he noticed. Furthermore, we may legitimately surmise that a mountain like Black Comb must by its commanding position between the mountains and the sea have been a critical influence in awakening Wordsworth to the consciousness of those "two voices", one of the sea, one of the mountains, "each a mighty voice", of which he speaks in the ode, *Thoughts of a Briton on the Subjugation of Switzerland* (1807). Possibly it is this symbolism of the two greatest voices in the geographical environment of man which has now entered our general literature and even become colloquial.

Some even of the inferior pieces are very impressive in their reflexion of the climatic background of the fells, as, for example, *Fidelity*, which records a tragic event on Helvellyn, and *Lucy Gray*, which commemorates fatality in a snowstorm on the Westmorland moors. But apart altogether from specific allusion or description there is a quality in Wordsworth's poetical diction which conjures up the mountains before the reader in much the same way that Sir Walter Scott makes him feel the romance of the Cheviot Border country or Thomas Hardy conveys to him a lively sense of the Wessex countryside typified in the setting of cottages and hamlets half-buried in heaths and woods in the folds of lonely downs. Take, for example, the singularly fine reference in the prologue to the "Poems" as collected in the Oxford edition by Thomas Hutchinson, to the star

> "that burns
> Like an untended watch-fire, on the ridge
> Of some dark mountain ;"

This vivid portraiture conveys a message which may be received in any locality where high, bold ridges break the night sky-line, but it obviously drew its strength and inspiration from Wordsworth's own mountains.

It may, perhaps, be regarded as a tribute to Wordsworth's genius that upbringing in the Lake Country never lessened his appreciation of the softer types of English scenery as it might have done in the case of a lesser poet. In a patriotic sonnet written on landing at Dover he greets the beauty of "Kent's green vales", and of Oxford he declares in another sonnet that its spires, domes and towers, its gardens and groves, are a presence which overpowers the "soberness of reason"—words that do not read very comfortably of the overgrown industrialized city of to-day. It was the noble landscape of the lower Wye that instigated the philosophical masterpiece, the famous *Tintern Abbey Lines*, of July 1798 :

> "O sylvan Wye! thou wanderer thro' the woods,
> How often has my spirit turned to thee !"

Nor was the lover of the mountains blind to natural beauty in the heart of London, as witness the celebrated sonnet composed on Westminster Bridge in September 1807, commencing "Earth has not anything to show more fair". The poet's psychological reactions to the Metropolis as revealed in the poems can scarcely fail, indeed, to interest geographers. It is gratifying to read in one sonnet that he knew the view from Richmond Hill and had listened to the choir of nightingales on the banks of the placid Thames where, as he reminds us, the "poet of the seasons" [James Thomson] had done many years before. During Wordsworth's frequent visits to London in later life, particularly after he became Poet Laureate, he would walk across the fields to see literary celebrities at Hampstead, then a shaggy hill-top village connected with the City by tortuous country lanes shaded by stately elms in the manner so typical of a rural Middlesex of which now, alas ! so little remains. He records on one such occasion in 1835 having in company with a brother poet, the Reverend Thomas Crabbe, gazed from "Hampstead's breezy heath" upon London's black smoke wreath, which may well at that time have been more noxious, if less extensive, than nowadays. This reference occurs curiously in a poem with a north-country setting beyond the Border, entitled *Ex tempore Effusion upon the Death of James Hogg* [the Ettrick Shepherd], and is a good illustration of that geographical consciousness which will often cause Wordsworth to call up unexpectedly a particular locality in a remote context. It is, however, in the seventh and eighth books of *The Prelude*, describing early residence in London, that we meet with the most lively exhibition of regional consciousness in the capital. After driving through the "long labyrinth of the suburban villages" there came the wonderful moment when, for the first time, the poet could fairly say he had entered London's "vast dominion", a moment marked by an overwhelming sense of "weight and power". The obsession lasted but a moment, yet dwelt in time and "grateful memory as a thing divine". The spirit of Nature, he says, was upon him in London, and he explains that what he saw of the deeds and sufferings of humanity in the great city affected him as forcibly in their own way as the natural forces in Westmorland had done before.

> " Hence the place
> Was thronged with impregnations like the Wilds
> In which my early feelings had been nursed".

But one thought completely baffled him, that men in town could be next-door neighbours without even knowing one another's names. It is remarkable that this tradition, half humorously regarded, perhaps, should persist to-day through all the social and scenic changes which London has undergone in the hundred and fifty years since Wordsworth wrote, before even the hansoms had come to dominate the London scene. It is, indeed, a paradox of social environment that a huge city should permit a citizen to barricade himself with a degree of privacy which it would be futile to attempt in a village or country town.

Wordsworth's reaction to the flat country around Cambridge, as told in the third and sixth books of *The Prelude*, was likewise highly significant, though, perhaps, we may legitimately assume that here his susceptibilities were quickened by the cultured environment of the University itself. Going up to college a "stripling of the hills", a "northern villager", he acknowledges the influence over himself of the great company of youth into which he had entered in so famous a place, and of such abiding names as Newton, Spenser, Milton and Chaucer. Solitude, it seems, had only appealed to him in lonely places, and he even admits taking part in mad gallops across the country in "zeal of senseless horsemanship" and prolonged hilarious sailings on the Cam. But independence of spirit would lead him away now and then from companions in order to come to terms with the scenery of the plain and fenland of Cambridgeshire, which differs so radically from the Lake country that it would almost require the eye of a visitor from a remote quarter of the globe to pick out the minor resemblances between the two districts in terms of a common English landscape. Nevertheless, there was no nostalgic frustration in distance from the hills ; rather did the great seer find a fresh interpretation of Nature from the tamer scenery, discovering a fuller beauty in the wide expanses of earth and sky and a soul in everything. As he puts it :

> "ofttimes did I quit
> My comrades, leave the crowd, buildings and groves,
> And as I paced alone the level fields
> Far from those lovely sights and sounds sublime
> With which I had been conversant, the mind
> Drooped not ; . . .

. . . I felt
What independent solaces were mine
To mitigate the injurious sway of place
Or circumstance . . .
I looked for universal things; perused
The common countenance of earth and sky;"

We may leave this reference to the poet's Cambridge days by noting that he has given a picture of himself in college grounds gazing in visionary posture on frosty moonlit nights at a singularly graceful ash tree clad in ivy and heavily decked with rime or snow.

Another part of the country with which Wordsworth was closely associated in early manhood is that beautiful region in the south-west, where Somerset, Dorset and Devon meet. He passed the years 1795–97 in company with his sister Dorothy at a house not far from the foot of Pilsdon Pen in west Dorset within a field's length of the Devonshire border as it then stood, and the subsequent year, 1797–98, in the vicinity of Nether Stowey, amid the Quantock Hills, in west Somerset, where the Wordsworths were joined by Coleridge. This was a period of great literary activity, including the composition of "Lyrical Ballads", and the influence of the local scenery in both Dorset and Somerset can by internal evidence be seen in several poems written about the time. Nevertheless, the almost complete absence of direct topographical reference to this region must inevitably disappoint West Country devotees of the poet. It is true that in *Ruth* he gives a glimpse of the wild woods and gushing springs of Quantock, and that in the *Prelude* he recalls days spent with Coleridge on "Quantock's airy ridge" and "amid her sylvan combs"; but nowhere does he reflect the exceptional beauty of the Quantock country, derived in large measure from the magnificent hanging woods of the steep western side of the ridge and the glorious companies of trees where the winding wooded combes widen to the swelling foothills on the eastern side. Nor is there any description of the neighbouring Exmoor glens with their lovely, lonely streams opening to the high grand coast by Lynton, which the poet friends more than once visited. Particularly interesting would it have been to know the spiritual response of this great Cumbrian lover of Nature to the very distinctive Dartmoor country, with its splendid river gorges; but there is no mention of the rugged tors anywhere, either in the poems or letters. Curiously, one of the very few references to Devon at all occurs in the *Guide through the Lakes*, where in the course of an account of a late autumn walk along the shore of Ullswater the poet's mind makes one of those sudden migrations in the manner geographically so interesting at the sight of the alders, which remained as green as the "Devonshire cottage myrtle which weathers the snows of Christmas".

Nevertheless, it is gratifying to read in the various published letters and journals of William and Dorothy how much brother and sister enjoyed the country around both their Somerset and Dorset homes. Dorothy compared the Quantocks to the less-grand parts of the Lake District, and William himself alludes to exhilarating walks over the Lyme Regis hills, where he could hear the murmur of the sea for miles. Moreover, by way of intimation that silence in the poems about a particular locality may be only accidental and not due to any lack of appreciation, we have William's own admission of neglect of his own vale of Eden:

"Eden! till now thy beauty had I viewed
By glimpses only, and confess with shame
That verse of mine, whate'er its varying mood
Repeats but once the sound of thy sweet name".

Space will not permit mention of all the districts of England of which the reader of the poems gets a glimpse; but one or two further citations may be chosen before passing to a brief notice of other parts of the British Isles and the Continent. Although archæologists have a much wider grasp of the Stonehenge problem than when Wordsworth wrote, it still presents a challenge and may never really be solved. This is how the poet personifies the monument in its geographical setting upon the bleak chalk uplands of Salisbury Plain:

"Pile of Stonehenge! so proud to hint yet keep
Thy secret, thou that lov'st to stand and hear
The Plain resounding to the whirlwind's sweep".

That much-abused poem *Peter Bell* is at least redeemed by a few quite exciting landscapes, as, for example, in the couplet wherein it is told of Peter who, it will be remembered, was quite insensible to a primrose by a river's brim that he, all unmoved,

"Had heard the Atlantic surges roar
On farthest Cornwall's rocky shore".

The concluding or fourteenth chapter of *The Prelude* opens with the description of a night ascent of Snowdon to see the sunrise, which is valuable both as a meteorological record and as an illustration of Wordsworth's exquisite sensibility to natural impressions among mountains. The party, comprising the poet, a friend and a guide, left Beddgelert on a warm summer evening, and after mounting through the fog-wreaths of the lower slopes emerged on to the clear heights where

"The Moon hung in a firmament
Of azure, without cloud, and at my feet
Rested a silent sea of hoary mist,
A hundred hills their dusky backs upheaved
All over this still ocean; . . .
Not distant from the shore whereon we stood
A fixed abysmal gloomy breathing-place—
Mounted the roar of waters, torrents, streams
Innumerable, roaring with one voice!
Heard over earth and sea, and in that hour,
For so it seemed, felt by the starry heavens".

Amid many Scottish scenes, one of the glen of Loch Etive (*Yarrow Revisited* and other poems) may be cited as in some respects more effective than a canvas in suggesting the ever-changing expression of the mountains in a region where the ocean tempests follow on with a rapidity exceeded in few parts of the world. The sonnet in the voice of the Muse opens:

"'This land of Rainbows spanning glens whose walls
Rock-built are hung with rain-bow coloured mists
Of far-stretched Meres whose soft flood never rests—
Of tuneful Caves and playful Waterfalls—
Of Mountains varying momently their crests—
Proud be this land! whose poorest huts are halls
Where fancy entertains becoming guests
While native song the heroic past recalls"'.

The letters of William and Dorothy Wordsworth, edited by the late Prof. de Selincourt, show, what the poems completely conceal, that the poet made an extensive tour of Ireland in the early autumn of 1829. His observations on the life and customs of the country and of little incidents by the wayside are to a geographical mind most interesting. Though not considering the scenery of Ireland as a whole to rival

that of the larger sister isle, he thought the lakes of Killarney surpassed in majestic beauty his own Cumbrian lakes. He further points out what some who have not visited the district may not know, that the mountains of Kerry harbour an immense number of tarns, far in excess of those in Cumberland, Westmorland and North Lancashire.

The Continental tours, on the other hand, are abundantly mirrored in the poems, where we read, for example, of the castles of the Rhine, the vine-clad slopes of Burgundy, the antiquities of Bruges and the forests of the Loire, as well as wanderings farther afield in Switzerland and Italy. Truly Wordsworthian in its attachment to place is the farewell (opening the tenth book of *The Prelude*) to the fair landscape of the Loire on the return to the strife of Paris soon after the fall of Louis XVI :

"It was a beautiful and silent day
That overspread the countenance of earth,
Then fading with unusual quietness—
A day as beautiful as e'er was given
To soothe regret, though deepening what it soothed,
When by the gliding Loire I paused, and cast
Upon his rich domain, vineyard and tilth
Green meadow ground, and many-coloured woods
Again, and yet again, a farewell look :"

As might be expected of one brought up among mountains at home, he was highly susceptible to the sublime grandeur of the Alps. Some critics have said, indeed, that nothing in the whole range of Wordsworth's landscape can vie with the *Simplon Pass* (appearing separately among the "Poems of the Imagination", as well as in the sixth book of *The Prelude*), of which a fragment runs :

"The torrents shooting from the clear blue sky
The rocks that muttered close upon our ears,
Black drizzling crags that spake by the wayside
As if a voice were in them . . ."

Not so well known as this is the splendid Alpine scene in *Descriptive Sketches* of a peasant woman sheltering from an evening thunderstorm beneath one of the covered bridges of the Swiss canton of Grisons or Gräubunden :

"When lightning among the clouds and mountain snows
Predominates, and darkness comes and goes
And the fierce torrent at the flashes broad
Starts like a horse beside the glaring road
She seeks a covert from the battering shower
In the roofed bridge ; this bridge in the dread hour
Itself all trembling with the torrent's power".

In thus depicting the behaviour of the torrent the poet surpasses himself in imaginative power, and seems to be pointing beyond the crude physical forces. Arresting also is an anticlimax to the above scene :

"Nor is she more at ease on some still night
When not a star supplies the comfort of its light
Only the waning moon hangs dull and red
Above a melancholy mountain's head".

The truth of this picture as landscape impression will be recognized by all who have ever wandered among rugged hills at night-time.

Wordsworth saw a good deal of the Italian lakes at different times. In one or two places in *Descriptive Sketches* and *The Prelude* he has rendered with the utmost fidelity the atmosphere of the Lake of Como sweeping beneath chestnut-clad steeps threaded with vine-clad pathways leading from villa to villa and village to village. As you proceed northward along this noble lake the increasing severity of the scenery proclaims most emphatically the thoroughly Alpine character of this very deep basin, with its sudden violent storms, a fact not lost on the poet :

"With those delightful pathways we advanced,
For two days' space, in presence of the Lake
That stretching far among the Alps, assumed
A character more stern . . ."

Though frustrated in the attempt to reach Naples and the south by that ever-menacing scourge of the early nineteenth century, cholera, his desire to wander through Tuscany, Umbria and Lazio was fulfilled :

"The beauty of Florence, the grandeur of Rome,
Could I leave them unseen and not yield to regret ?"

It is obvious that Wordsworth felt, even if he did not so express it, what Ruskin, Browning, Arnold of Rugby, and other English lovers of Italy have felt, that the Apennines play a tremendous part—physical, economic and spiritual—in the geographical personality of the country.

How differently, indeed, might have run the very course of history in the absence of this mountain system, which with a character more subdued than that of the Alps dominates the entire peninsula, enclosing within its bold spurs and bleak tablelands pockets and folds of exquisite beauty. Perhaps the best of the Apennine sketches are contained in the delightful musings near Aquapendente (Acquapendente) in April 1837 :

"Yon snow-white torrent-fall, plumb down it drops
Yet ever hangs or seems to hang in air
Lulling the leisure of that high-perched town
Aquapendente in her lofty site
Its neighbour and its namesake—town and flood
Forth flashing out of its own gloomy chasm
Bright sunbeams—"

Then looking from a green lawn strewn with grey rocks over waste ground profuse with golden broom, he spies a cone-shaped hill with fractured summit, "bleak Radicofani", which characteristically turns his thoughts homeward—to his own Fairfield, whose feet would soon likewise be attired in golden blossoms. And so from distant Italy we return suddenly to the natural focus of the great poet's thoughts, the English Lakes.

After this brief review of the poet's wanderings it might be noted that just as regions which he knew are not mentioned in the poems, so others which he never visited, including distant parts of the world, do receive mention, though such references are for the most part conventional and uninspired, calling for little notice here.

William Wordsworth's relation to geography is seen not only in his regional consciousness and rendering of local colour, but likewise in his habitual contemplation of human life on the stage of natural scenery. Though no narrow determinist, he yet saw that landscape exerts an influence in moulding the mental and spiritual outlook of men as so strikingly illustrated in his own development. Moreover, through every class of poem there runs a wealth of landscape imagery through which is revealed the most intimate feeling and delicate perception. This is exemplified, for example, not only in the two great masterpieces the *Tintern Abbey Lines* and the ode on *Intimations of Immortality from Recollections of Early Childhood*, but likewise in numerous lesser poems. Take those very favourite oft-quoted verses wherein the poet speaks of the treasure he had found in the sudden sight of a great host of daffodils dancing in the breeze by a lake shore :

"They flash upon that inward eye
Which is the bliss of solitude".

Relationship to geography naturally links up with general attitude towards science. Wordsworth has been accused of hostility towards science on the flimsy pretext that once or twice in the poems he shows impatience with a certain rather narrow type of geologist or botanist whom he had met in the field and who may partly have deserved his strictures. The issue, however, must be judged on wider grounds than this. Apart from the fact that in one of the prose prefaces bound up with the Oxford edition the author expressly states that the remotest discoveries of the chemist or physicist may one day become the proper theme of the poet's song, the entire tenor of Wordsworth's poetry suggests tacit acceptance of scientific principle. There is a lengthy passage towards the end of *The Excursion* which has to-day quite a prophetic ring in hinting at the dangers to mankind inherent in gaining without moral purpose too much control over the forces of Nature. He saw that truth is one, and that by coming to terms with scientific discovery he would be lending strength and stability to his own spiritual vision. This is no doubt why the poet often commends himself to men of science, and it is at least significant that the first editor of *Nature*, Sir Norman Lockyer, should have selected as the motto for this scientific journal the words which have remained on its cover ever since :

"To the solid ground
Of nature trusts the Mind that builds for aye".
("Miscell. Sonnets", Pt. 1.)

As Harper, certainly not the least discerning of his biographers, has pointed out, Wordsworth instinctively knew how far he could safely go in the imaginative interpretation of Nature, and time and again he pulls himself up when confronting scientific knowledge. Often he will bring the scientific and æsthetic aspects of natural phenomena into line, as though endeavouring to harmonize the two. Thus there is a curious metaphysical passage in the second book of *The Prelude*, wherein the poet in describing his affection for the sun and moon, both as heavenly bodies and as elements in the local landscape, seems trying with perplexity to co-ordinate scientific knowledge with poetical feeling. Of the lesser luminary he says :

"Analogous, the moon to me was dear ;
For I could dream away my purposes,
Standing to gaze upon her while she hung
Midway between the hills, as if she knew
No other region, but belonged to thee,
Yea, appertained by a peculiar right
To thee, and thy grey huts, thou one dear Vale !"

It is just when we study the great poet in the field of scenic impression that we see that he did more by his outlook upon Nature to lessen the gap between science and the humanities than was apparent in his own time or than perhaps could have been apparent to the Victorians, with their more rigid dualistic conception of the universe. Of various noble passages which might be selected to symbolize his teaching, none suits the context of this article better than the words which he applies to one of his own characters :

"His daily teachers had been woods and rills
The silence that is in the starry sky
The sleep that is among the lonely hills".

SCIENCE OF WEATHER

THIS year, on April 3, the Royal Meteorological Society celebrated its centenary. In honour of this occasion the Director of the Science Museum has presented a special exhibition, portraying modern instruments and techniques in meteorology, and their impact on everyday life. The exhibition was formally opened on March 27 by the Lord President of the Council, the Right Hon. Herbert Morrison, at a ceremony in the lecture theatre of the Science Museum, presided over by the Minister of Education, the Right Hon. George Tomlinson. It will remain open until June 25.

The president of the Royal Meteorological Society, Sir Robert Watson-Watt, spoke of the growing importance of South Kensington as a meteorological centre. The connexion between the Science Museum and the 1851 Exhibition is well known ; South Kensington was also at one time the home of the Meteorological Office—the South Kensington office was operating up to the outbreak of the Second World War. The removal of the Royal Meteorological Society to its present home in South Kensington, and the growth of the Department of Meteorology in the Imperial College of Science and Technology, under Sir David Brunt, have firmly established meteorological interests in the district. In commenting generally on the observational network which is being progressively elaborated each year, Sir Robert remarked on the fact that weather observations, besides demanding adherence to a difficult time-schedule, are also inherently difficult to make. Hence observing instruments and techniques require the most careful and continuous examination. At the conclusion of his address, he expressed, to the Director of the Science Museum, the Society's sense of honour at the choice of this occasion for staging a meteorological exhibition.

Mr. Herbert Morrison began his opening address by stressing the importance of special exhibitions in the Science Museum, since they provide an excellent means of letting the public know what scientific men are saying and doing. The weather and the weather forecast service are matters of great public importance, and there is an insistent demand for ever greater accuracy of forecasting, notwithstanding that the Meteorological Office forecasts for the London area are already correct nine times out of ten as regards rainfall. Practising forecasters will be grateful for the Lord President's sympathetic reference to the fact that they are called upon to make specific forecasts, even in situations in which they do not feel in a position to do so, whereas scientific men in other fields normally expect to be allowed to withhold judgment when confronted with an ambiguous situation.

The exhibition, "The Science of Weather", is divided into five sections, called respectively "A Century of Meteorology", "Weather Observations", "Forecasting the Weather", "Weather in our Daily Lives" and "Meteorological Research".

The first century of the Royal Meteorological Society has witnessed the transition of meteorology from a mainly observational study to a coherent science, exhibiting an extensive understanding of the physical processes occurring in the earth's atmosphere, or, at least, in the troposphere and lower stratosphere. Since, however, the Exhibition marks the centenary of the Royal Meteorological Society, the historical

section, "A Century of Meteorology", is concerned primarily with that Society during its first hundred years, and makes no pretence of portraying the complete history of meteorology since 1850. The topics illustrated, chosen mainly to do honour to the Society, include publications of the Society, the establishment of Ben Nevis Observatory, and the work of two former presidents, Sir W. Napier Shaw and Mr. W. H. Dines. With regard to the publications, which provide a summary of the state of meteorological science at various stages during the past century, it is of interest to note that the Royal Meteorological Society has so recently as 1946 embarked upon the publication of a new popular monthly magazine called *Weather*, in addition to its more technical and academic *Quarterly Journal*.

The establishment of Ben Nevis Observatory by the Scottish Meteorological Society in the latter half of the nineteenth century was part of a world-wide movement to institute routine observations at mountain stations. To a peculiar degree the operation of such an observatory imposed a very difficult time-schedule upon the observer, such as Sir Robert Watson-Watt had referred to in his address. The Observatory was closed in September 1904; but its work remains a monument to the Scottish Meteorological Society, which was incorporated into the Royal Meteorological Society in 1921, and to Dr. Alexander Buchan, to whose efforts the installation and continued operation of the Ben Nevis Observatory were largely due. The exhibit includes some of the original instruments and record books.

The two personalities selected for representation are Sir W. Napier Shaw (1854–1945), whose long life thus nearly spanned the hundred years now being celebrated, and Mr. W. H. Dines (1855–1927). The former was most active in the organisation of meteorological studies, and his four-volume "Manual of Meteorology", first published in 1926, remains a valuable source of reference. The exhibit illustrating Sir Napier Shaw's work consists of a sequence of drawings of the winds circulating around a depression. These drawings, arranged for examination in a zoetrope, give a vivid impression of the wind circulation, as visualized before the modern frontal theory was developed.

W. H. Dines's contribution to meteorology was of a very different character. His interest in the subject was first aroused by the disaster of the Tay Bridge, which was carried away by a squall of wind in 1879. He applied his very great inventive ability to the study and measurement of wind, a phenomenon greatly complicated by turbulence; and several of his wind-speed devices are shown in the exhibition, including the pressure-tube anemometer, with which his name is indissolubly linked. The other aspect of his work illustrated is that dealing with the meteorograph. This instrument has now been made obsolete by the *radiosonde*; but, at the time, W. H. Dines made an important contribution to the subject by producing a model which did not require the heavy clockwork mechanism favoured elsewhere, and could therefore be sent to greater heights.

The second section, "Observing the Weather", illustrates particularly two modern aspects of meteorological observations. The first is the increasing extent to which naked-eye observations are being superseded by instrumental observations; the second is the very great prominence now being given to upper air sounding.

Many weather phenomena, such as type of cloud observed or of precipitation, though not susceptible of instrumental techniques, are nevertheless of the greatest importance to the forecaster, because of the valuable indications they give of the physical processes occurring within the atmosphere. Apart from such phenomena as these, however, there are many meteorological quantities the routine determination of which was for a long time left to the senses unaided by special instruments, and which are gradually being brought within the realm of instrumental techniques. We may cite cloud-base height, visibility, and wind-speed measurement. Moreover, the organisation of the Ocean Weather Service and of meteorological reconnaissance flights reflect a determination to fill the gaps in the chart in those parts of the oceans not normally traversed by shipping lines.

The first of the principal objects of the British (now Royal) Meteorological Society, at the time of its foundation a century ago, was: "A collection of correct manuscript observations". The importance of upper-air sounding to a proper appreciation of the meteorological situation has been recognized throughout the past century; but only in the past decade has it been possible to extend this exploration, as a routine process over a wide area, from the earth's surface upwards throughout the troposphere and into the lower stratosphere. This has been made possible by the *radiosonde*, an airborne transmitter carried upwards to a height of as much as 60,000 ft. by a hydrogen-filled balloon, and designed to transmit coded signals, defining the pressure, temperature and humidity of the various layers of atmosphere through which the instrument is being carried. The *radiosonde* display exhibits the transmitter in considerable detail, and includes a working demonstration of the ground-station procedure. To emphasize the important place occupied by routine meteorological observations of the upper atmosphere, a *radiosonde* balloon was launched from Hyde Park during the opening ceremony, and the signals from it were received on a ground station in the exhibition gallery itself. Adjacent to the *radiosonde* exhibit is a display describing the radar measurement of upper winds.

Another topic of great importance, the location of thunderstorms, though not specifically a branch of upper-air sounding, receives special attention in the exhibition. A special display shows the radio method which has come into routine use in the Meteorological Office.

The third section of the exhibition is entitled "Forecasting the Weather". An essential preliminary to forecasting is the collection of weather observations from a large area, and their presentation to the forecaster in a readily assimilable form. The area to be covered by a weather chart depends upon the forecaster's purpose; but the chart will in any event require a knowledge of the weather at several hundreds of stations, several times daily. The 'weather code' and 'station plotting model', which have been developed to meet this double need, are integrated into a single working display in the exhibition. Forecasting procedure is illustrated by two series of weather charts: (i) for August Bank Holiday, 1949; (ii) for *D*-Day. The Daily Weather Reports, which are issued by the Meteorological Office, are being posted in the exhibition gallery for the duration of this exhibition.

As a counterpart to the historical exhibit, mentioned above under the name of Sir Napier Shaw, the 'Forecasting' section of the exhibition shows a model illustrating the three-dimensional structure of a warm-sector depression, based upon a depression that crossed the British Isles in January 1946.

In the fourth section, "Weather in our Daily Lives", it has been necessary to select a few topics for illustration from the very considerable range of subjects. Transport—land and air transport, and shipping—are examples of undertakings manifestly affected by the weather, and dependent upon meteorology for their most efficient operation. Other topics illustrated in this section are agriculture (including a model illustrating the effect of a shelter-belt protecting an orchard), water supply, electricity supply (including a model of a projected 100-kW. wind generator), climate and house design (including an illustration of an investigation by the Building Research Station of the Department of Scientific and Industrial Research on a group of experimental houses at Abbott's Langley), atmospheric pollution, and civil engineering (this is illustrated by an exhibit dealing with the determination of the fine structure of the local wind, in connexion with the design of the proposed Severn Bridge).

In the fifth section of the exhibition, "Meteorological Research", the following topics are illustrated: cloud physics, turbulence, radiation, upper atmosphere, atmospheric sounding, and synoptic meteorology. Radio, and especially radar, methods of investigation have substantially improved the meteorologist's ability to study cloud processes *in situ*, and a number of charts and photographs show methods of studying free water in clouds, and the wave-form of lightning discharges. Working demonstrations are provided of a method of determining drop-size distribution in a cloud or in rainfall, and of the growth or decay of a hygroscopic particle when subjected to an atmosphere of variable humidity. A display of very wide appeal is a cloud chamber in which periodical demonstrations are given of the principle of the artificial production of rain from a cloud containing supercooled water droplets, by seeding with solid carbon dioxide.

The exhibit dealing with turbulence is concerned with turbulence occurring within a few feet of the ground, and shows a variety of pieces of apparatus developed for measuring the phenomenon.

Radiation research is represented by ozone spectrophotometry. Dr. G. M. B. Dobson's original instrument is exhibited, together with drawings and photographs of the modern commercial instrument developed from it. Accompanying the apparatus are charts showing the correlation of ozone content with weather.

In studies of the upper atmosphere, radio investigations of the ionosphere have confirmed the existence of high wind velocities at that level, which had already been deduced from the examination of luminous night clouds and of the polar aurora. The evidence for these winds is displayed, with a working model explaining how the notion of a wind at ionospheric level may be deduced from observations of radio fading, and its speed and direction measured.

The general title "Atmospheric Sounding" has been used to describe a group of exhibits illustrating research into instruments for various observations: the frost-point hygrometer, as developed to measure frost-point temperatures as low as − 80° C.; an airborne radar 'transponder' which will enable the range of radar wind-finding equipment to be increased to about a hundred miles; and a photo-electric visibility meter.

Research in synoptic meteorology is illustrated by two exhibits: one is a series of weather-charts representing research now being pursued in Great Britain to extend the period of useful forecasting; and the other shows how observations of wind-finding balloons may be applied to measuring large-scale vertical motions in the atmosphere.

A collection of current books on meteorology and weather is included in the exhibition.

D. CHILTON

HIGHER TECHNOLOGICAL EDUCATION IN GREAT BRITAIN

A SPECIAL conference on higher technological education in Great Britain was held in the rooms of the Royal Society on the afternoon of March 27, under the chairmanship of Sir Henry Tizard. The conference had been arranged by the Advisory Council on Scientific Policy with the view of bringing together those primarily interested in future policy for the organisation of higher technological education in the United Kingdom. Those present included the president and several fellows of the Royal Society, representatives of the Ministry of Education, the University Grants Committee, the Advisory Council on Scientific Policy and university departments of applied science, together with a number of the contributors to recent correspondence in *The Times* and others who had shown a special interest in the subject. Mr. M. J. Kelly, executive vice-president of the Bell Telephone Laboratories in New York, also attended by invitation and gave a short address.

Sir Robert Robinson, president of the Royal Society, in opening the proceedings, said that he thought it was most valuable to have a conference of the sort which had been organised with the view of bringing together advocates of the different policies which had recently been supported. He suspected that some of the differences were not so deep as they might at first sight appear to be. Sir Henry Tizard said that it is a matter of common agreement that it is vital to the interests of Great Britain to increase rapidly the output of those who could apply the fundamental principles of science. Discussions at meetings of the Advisory Council on Scientific Policy and elsewhere had shown an unfortunate divergence of opinion about how this could best be done, and he feared that if agreement were not reached, effective action of any sort might be delayed.

The first speaker to give his views was Lord Cherwell, who said that the vital need of Great Britain after two costly wars is to increase exports, since otherwise a disastrous fall in the standard of living would occur. For this purpose the important thing is to translate scientific knowledge into application. So far there is general agreement; the present controversy turns on the question whether the technical education required can be best provided by university departments of applied science or by independent institutes of higher technology. He believes that the decisive reason why the universities would not be able to do the work effectively is that they could not, without changing their whole character,

undertake an expansion of the order necessary to educate the numbers of students who should receive education in higher technology. Apart from this, higher technological education could not be carried out effectively or economically unless it is given in very large institutions attended by some two to four thousand students. Such numbers could not be absorbed by any existing university in Great Britain, except perhaps London, and he therefore thinks it desirable to create a number of technical universities or colleges of the calibre of the Massachusetts Institute of Technology or the Zurich Technical High School. The cost of building such an institute would probably run to £4–5 million.

Prof. J. F. Baker, professor of engineering in the University of Cambridge, said that the qualifications of a technologist in the strict sense are exacting. He requires a sound grounding in the fundamental sciences; he has to be a considerable mathematician; and he has to undergo the discipline of dealing with particular problems in detail and judging what is a practicable solution. He also requires a certain knowledge of methods and processes in actual use if he is to collaborate successfully with the technician. Such of these qualifications as cannot be acquired at a university are best obtained through practical experience in industry. Prof. Baker said that he sees no reason why facilities for higher technological education should not be considerably expanded at such centres as the Imperial College of Science and Technology, London, and the University of Birmingham; but if this policy is to be successful he believes a new attitude would have to be adopted to engineering technology. In Great Britain such technology is greatly prejudiced by the prevailing tradition that practical techniques are not the business of universities, whereas in the United States the opposite attitude is universally adopted. Prof. Baker agreed that there may be something to say for a technical university if it could be provided ready-made; but he felt that the cost in money and man-power of building it and staffing it adequately would be prohibitive. It would take years to put such an institution into running order, and this could only be done at the expense of existing institutions which, however imperfect, are already producing students and research, and are rapidly achieving a higher level of efficiency by the development of postgraduate courses.

Mr. H. Richardson, principal of the Technical College, Bradford, made a plea for developing higher technological education in some of the major technical colleges. He recalled that the Percy Report recommended the upgrading of some of these colleges for this purpose, and said that the saving of material and labour which would be effected by this policy is a vital consideration at the present time. Some of the local colleges are giving more and more of their attention to higher technology and a few have reached the standards of the university colleges. The main difficulty which faces them in carrying out this work, he said, is the fact that they are governed by the local education authorities and financed largely from the local rates, so that they cannot offer the same terms of service to their staffs as universities. With a new system of financing and government, there is no reason why some of these colleges should not discharge the functions of the special institutes of higher technology which Lord Cherwell advocated.

Prof. J. Kendall, professor of chemistry in the University of Edinburgh, believes that there is undue pessimism about technological education in the United Kingdom. His own experience is that the best technological students in Britain are fully equal to the best in the United States or on the Continent; but it has to be recognized that the American institutions are financed on a much more lavish scale. With more financial support the Imperial College could embark on a large-scale development. In some universities the problem has been solved by developing a close relationship between the university and the leading technical college in the area. A good example is the working arrangement made between the University of Edinburgh and the Heriot-Watt College. Much could be done to promote higher technological education if the work of universities and technical colleges were better correlated.

In the subsequent discussion, Sir John Cockcroft supported the view that special institutes of higher technology are necessary. He agreed that the simplest way of creating them, if it were practicable, would be to raise the status of some of the technical colleges by changing their method of government and finance.

Sir Roderic Hill, rector of the Imperial College of Science and Technology, said that the College could increase its present rate of expansion very considerably if necessary; but he thought it would be in the best interest of the College not to do this.

Prof. A. R. Todd, professor of chemistry in the University of Cambridge, expressed doubts whether the universities could organise the desirable expansion in higher technological education without becoming lop-sided.

Dr. A. E. Trueman, chairman of the University Grants Committee, said that there is no evidence that the demand of industry for higher technologists will be greater than the universities can meet. It is, no doubt, a distinct question whether industry ought to demand a greater number of higher technologists; but he believes much harm would be done if the expansion were such that higher technology became a field of unemployment.

Advantage was taken of the presence in Great Britain of Mr. M. J. Kelly, executive vice-president of the Bell Telephone Laboratories, New York, to obtain his views on technological education. He said that British industry would benefit from an increased number of higher technologists, and the only question in doubt is how this increase could be most quickly achieved. In his opinion, universities are definitely less satisfactory for the conduct of higher technological education than special institutes like the Massachusetts and California Institutes of Technology. In universities, there tends to be too much separation between pure science and engineering; but in these special institutes the two subjects are closely associated. Once the supply of higher technologists in Britain is appreciably increased, it would be possible to appoint more of them to leading executive positions in industry, a practice from which American industry has greatly benefited.

Mr. G. J. Nash, of the Appointments Department of the Ministry of Labour, said that his Department's statistics support Dr. Trueman's view that the demand for higher technologists by British industry does not greatly exceed the present supply, and shows no signs of increasing substantially.

Sir Lawrence Bragg expressed his belief that the proper work of the universities would be adversely affected if they were given the responsibility of increasing the output of higher technologists. On the other hand, he felt that technical colleges under local

control would not provide a satisfactory foundation for the work. He therefore supported the view that the best place for the education of a higher technologist is a special institute of higher technology, and he hoped that the experiment of setting up at least one such institute in the United Kingdom would be undertaken. Prof. S. Zuckerman said he agreed that at least one institute of higher technology should be set up. He had been greatly impressed by the excellence of the research as well as the teaching work which he had seen at the California Institute of Technology, and thought that a college of the same general sort would be of great value to the United Kingdom.

Prof. R. S. Hutton said that a study of the history of the German technical high schools showed that it takes about twenty years to get these into proper working order and establish their reputation. Thus if a demand for such colleges is anticipated in the future, it is important to proceed with the plans quickly. He himself has no doubt that the qualifications demanded of the higher technologist are most successfully acquired in such institutions.

Prof. A. R. J. P. Ubbelohde said that the increase in technologists is required primarily in the top grades, and this constitutes a basic difficulty in utilizing local technical colleges for their training.

At the conclusion of the proceedings, Sir Henry Tizard thanked those who had contributed to the discussion, and said that the Advisory Council on Scientific Policy would give the matter further consideration in the light of the views which had been expressed.

OBITUARIES

Mr. A. J. Wilmott

ALFRED JAMES WILMOTT died suddenly at South Kensington on January 26. He had given a students' lecture on "Geographical Distribution and Classification" at the Linnean Society the evening before.

He was born at Tottenham on December 31, 1888; but his parents soon moved to Cambridge, when his father, Alfred John Wilmott, was appointed lecturer in history and classics at Homerton Training College.

Young Wilmott soon showed that faculty of rapidly acquiring knowledge which lasted throughout his life. He gained an entrance to the new Cambridge County School, and from there a scholarship to St. John's College in 1906. As he was the first pupil of the School to go up to the University, he had been invited to speak at the jubilee celebrations to be held in July next, and had intended to hurry back from the International Botanical Congress at Stockholm to do so.

He early became interested in outdoor natural history, being encouraged by his father, who was a man of wide culture. At first entomology most attracted him; but at school Dr. Marion Dawson, who was biology mistress, turned his attention to her own special branch—botany. When he went up to the University his knowledge of field botany was much greater than was then usual among undergraduates.

At the University he obtained a first in both parts of the Natural Sciences Tripos, and was awarded a Hutchinson Scholarship at St. John's and the Frank Smart Prize. Like most who then did botanical research at Cambridge he was attracted by physiology, and worked under Dr. F. F. Blackman. He devised a glass 'bubbler' which, when fitted on to the cut stem of a submerged water plant, caused the liberated bubbles to be of a definite and constant size: the bubbles were delivered directly into a cup so that they did not enter into direct contact with the solutions that were being used. My own feeling is that Wilmott would have made a mark in plant physiology, for he had an aptitude for devising ways and means, and his fertile and imaginative mind would have benefited by precise and exact chemical and physical answers to his philosophizing.

Wilmott's knowledge of the flora of Cambridge brought him into contact with C. E. Moss, who had been appointed curator of the Herbarium in 1908, and who gave stimulating lectures on botanical taxonomy. When the Department of Botany, British Museum (Natural History), announced the impending appointment of an additional assistant to work at British and European plants, Moss suggested that he should become a candidate. Competition in those days was by examination, and Wilmott was successful, but did not take up his duties until May 1911. When he arrived, the European room had been built and a few cabinets installed. His first task was to extract the European plants from the general collections (the British plants had been segregated by Robert Brown in 1849). For the whole of his Museum career Wilmott was engaged in incorporating collections—an enormous task still far from completion, for there have been constant large and important accessions which have made the British and European Herbarium without a rival. It was his claim that his arrangement of unincorporated material ensured that every specimen was available for consultation. Whatever future rearrangements may have to be made because of expansion, Wilmott's curatorial work, extensive and precise, will remain as a solid foundation.

It is more difficult to assess Wilmott's scientific status. It cannot be gainsaid that he greatly influenced those studying British plants by his ever-ready help in the herbarium, by his insistence on accuracy—an insistence often most strongly expressed—by his wide knowledge of the habitats of British plants and the factors concerned in their distribution, and by his extensive acquaintance with the European flora. He was much in evidence in the affairs of the Botanical Society of the British Isles, sparing no pains in furthering its objects: he was in many matters the final authority, and this appreciation did much to stimulate him.

Wilmott was a man of ideas and of schemes. Unfortunately he did not possess the faculty of pressing on regardless of attractive side-lines, and became enmeshed in many of these.

He contributed the account of the genus *Atriplex* to the Cambridge Flora. He acted as editor to the tenth edition of Babington's "Manual of British Botany" (1922) at Mrs. Babington's request and provided an appendix to include the most important additions since Babington's death. For the most part his publications consist of short papers, the principal ones dealing with marsh orchids, *Sorbus*, *Alchemilla*, *Rhinanthus* and *Salicornia*; he had been engaged on a monograph of the British species of *Salicornia* for many years and it was nearing completion.

He was a convinced believer in the survival of a relict glacial flora and became the chief British exponent of the theory.

Nomenclature had an abiding attraction for him throughout his career, and his clear and logical treat-

ment of many problems gained him an international reputation: indeed, I know of no one who excelled him in critical analysis; but, unfortunately, this was not accompanied by a practical constructive ability. For several years he applied himself to the nomenclature of units below that of species and in their definition and typification.

He botanized widely in the British Islands for many years in company with Francis Druce, who endeavoured to see every native species in its natural habitat. In 1927 he accompanied C. C. Lacaita to the Sierra Nevada.

Wilmott was a man of many talents, but lacked the power of co-ordination which would have enabled him to become one of the most eminent of systematists. It was this failing which accounted for a manner which, occasionally boyish, was sometimes formidable to those who met him for the first time, for with his huge frame and excited criticisms he was wont to strike terror in the uninitiated. But beneath it all there was a gentle kindliness which was invariably shown when assistance was needed.

Having regard to his somewhat ungainly figure it is remarkable how he excelled at games of all kinds. His 'soccer' was ended in his undergraduate days by a displaced cartilage, but he continued with other games to the very end: his dislike of solitude may have had something to do with this. He was an international table tennis player and three times won the British Veteran's championship. He was also an accomplished pianist and violinist. J. RAMSBOTTOM

Dr. Helgi Pjeturss

DR. HELGI PJETURSS, an Icelandic scientist of outstanding distinction, died at his home in Reykjavík on January 22, 1949. He was born in Reykjavík on March 31, 1872. His mother's family were Icelandic Government officials; but his father's ancestors were gifted farmers in northern Iceland. After passing through the grammar school at Reykjavík, 1891, he studied zoology and geology at the University of Copenhagen and took his degree there in January 1897. In the summer of 1897 he was the geological member of a Danish scientific expedition to Greenland, where he carried out some remarkable researches. Returning to Iceland in 1899 he worked on the geology of Iceland, and during following years many geological papers by him appeared in Icelandic, Danish, English and German. He published the main results of his researches in the thesis for his doctorate (Copenhagen, 1905), "Om Islands Geologi" (On the Geology of Iceland). In his book "Island", a volume of the "Handbuch der regionalen Geologie" (Heidelberg, 1910), he described in detail his geological investigations in Iceland.

Dr. Pjeturss proved that the Dolerite and Palagonite formation of Iceland was not Pre-glacial, as had been generally held, but was formed during the Glacial age. His discovery of glacial facies in the Palagonite formation was announced in the *Scottish Geographical Magazine* (May 1900). It was at first received with some incredulity; but his find of arctic shells (for example, *Portlandia arctica*, Gray), together with boulder clay, in these hotly disputed strata, proved his conclusion that the Palagonite formation was, at any rate to a considerable extent, contemporaneous with the Pleistocene epoch. This was fundamental for Icelandic geology.

In addition, Dr. Pjeturss investigated more thoroughly the Crag formation in Tjörnes, especially its thickness and relationship to other strata in Iceland. He discovered post-glacial raised beaches, which had not been recognized before, in many places in Iceland.

In his later years, Dr. Pjeturss wrote extensively on philosophy and cosmogony. He attempted to investigate dreams and other difficult mental problems, and to explore the possibility of the continuation of our earth life on other stars. He maintained that a more intimate knowledge of our own soul-life would enable us to solve this problem. All his writings on cosmogony were in Icelandic. They are full of original thought.

Dr. Pjeturss was a classical scholar and a great linguist. His Icelandic was of a singular and superior quality. A fine looking man, he was a great athlete and used to swim daily, even in his old age.

JÓHANNES ÁSKELSSON

NEWS and VIEWS

Marine Biology Station, Port Erin: Mr. J. S. Colman

MR. J. S. COLMAN, who has been appointed to the directorship of the Marine Biology Station at Port Erin, Isle of Man, brings to his new duties a rich experience of the seas, the conditions of life and the animals that live therein. He is a widely travelled zoologist, having done research in Florida, Woods Hole and Harvard University (while holding a Commonwealth Fund Fellowship), the Great Barrier Reef off Queensland, and Jamaica and St. Helena. As zoologist to the late Lord Moyne he was able to study the sea in a world tour. He may therefore be expected to offer no narrow point of view, particularly when his comprehensive experience as a teacher is taken into account—one-time associate professor of zoology at the Memorial University College, St. John's, Newfoundland, and latterly senior lecturer in zoology in the University of Sheffield. Mr. Colman's numerous published researches cover many aspects of life in the sea, including additions to our knowledge of the zooplankton, the morphology of coral reefs, the zonation of animals and seaweeds between tides, seal and commercial fisheries. These many interests have been happily brought together in his recently published book, "The Sea and its Mysteries". His present studies are chiefly directed to shore ecology, and a detailed investigation of part of the Yorkshire coast is now nearing completion. No doubt Mr. Colman's colleagues at neighbouring marine stations in Wales, Ireland and Scotland will look forward to a long and fruitful period of co-operation with him.

Central Research Establishment of the National Coal Board: Dr. J. Bronowski

DR. J. BRONOWSKI has been appointed director of the National Coal Board's Central Research Establishment at Stoke Orchard, near Cheltenham, and will take up his post on May 22. This Establishment is a new one and is designed to carry out research into the underground problems of mining, coal prepara-

tion, briquetting, carbonization, by-products, and mechanical and electrical testing. The work of the Central Research Establishment is dove-tailed with that of a number of other agencies to which the Board looks in carrying out research of interest to it. The National Coal Board's participation in the work of such agencies is co-ordinated by the director-general of research at headquarters, Dr. W. Idris Jones, to whom Dr. Bronowski will be responsible for the part played by the Central Research Establishment.

Dr. Bronowski, who is forty-two, is primarily a mathematician, but he has always been recognized for the wide range of his scientific interests; for example, while senior lecturer in mathematics at University College, Hull, he took part in work on physical, biological and economic problems. During the Second World War he joined Sir Reginald Stradling's team, at the Ministry of Home Security, set up to study and predict the physical and economic effects of bombing. He was a member of the Joint Target Group in Washington, D.C., and of the Chiefs of Staff Mission to Japan, which reported on the effects of the atomic bombs at Hiroshima and Nagasaki. At present Dr. Bronowski is assistant chief scientific adviser at the Ministry of Works and is engaged on mathematical and statistical investigations into the structure of industry, with special reference to the building industries.

Physics at the Australian National University: Prof. E. W. Titterton

Dr. E. W. Titterton, of the Atomic Energy Research Establishment, Harwell, has been appointed to a chair of physics at the Australian National University. Prof. Titterton, who will work with Prof. M. L. Oliphant in the Research School of Physical Sciences, embarked on a research career after graduating with first-class honours in physics from the University of Birmingham. During the early years of the Second World War, he became a member of a small team working on the development of micro-wave radar devices; later, he formed one of the British nuclear research team which went to the United States, where he distinguished himself as a brilliant research worker and master of physical technique. He joined the Atomic Energy Research Establishment at Harwell on his return to Great Britain. Prof. Titterton will go to Australia towards the end of this year.

Meldola Medal for 1949: Dr. A. J. B. Robertson

On the recommendation of the Council of the Royal Institute of Chemistry, the Society of Maccabaeans has awarded the Meldola Medal for 1949 to Dr. A. J. B. Robertson, in recognition of his work, while under the age of thirty, on explosives and on the application of the mass spectrometer to the study of chemical reactions. Dr. Robertson is a graduate of the University of Cambridge, where he joined the Department of Colloid Science as a member of Prof. E. K. Rideal's team working on explosives, and studied the sensitiveness of explosives to heat. Using specially developed experimental methods, many high explosives were found to decompose quite smoothly, although very rapidly, at elevated temperatures, and the kinetic features of several decompositions were studied. The actual transition between thermal decomposition and spontaneous explosion was directly examined by novel methods with a number of high explosives. Several distinct mechanisms whereby this transformation occurs were found, and various theoretical relations were deduced. The sensitiveness of solid high explosives to impact was also related to fundamental kinetic and thermal data by the 'hot spot' theory. Robertson was awarded the Henry Humphries Prize by St. John's College, Cambridge, for this work, and in 1946 elected to a fellowship. He continued experimental work under Prof. Rideal at the Royal Institution on the catalytic pyrolysis of hydrocarbons, using a simple mass spectrometer as an analytical tool and for the direct detection of free radicals. In 1948 he was appointed a junior research fellow by the managers of the Royal Institution, and in 1949 to a senior studentship by the Commissioners for the Exhibition of 1851. He is at present developing his work on the direct study of free radical reactions, in the Davy Faraday Research Laboratory of the Royal Institution.

Madame Kovalevsky (185 –91)

Among the few women whose mathematical researches have gained international recognition, Madame Kovalevsky ranks very high. Most advanced books on differential equations refer to Kovalevsky's proof of the existence theorem, while books on advanced dynamics refer to Kovalevsky's top. She was born in Moscow on January 15, 1850, the daughter of Lieutenant-General Korvin-Krukovsky, and displayed a marked taste for mathematics at an early age. At the age of eighteen she was married to V. Kovalevsky, a palæontologist, and shortly afterwards they both went to study in Germany. For several years she took private lessons from Weierstrass in Berlin, and in 1874 took the degree of Ph.D., *summa cum laude* at Göttingen. After this she returned to Russia. In 1883, after the tragic death of her husband, she became an assistant professor at Stockholm, and made a deep impression by her exposition of Abelian functions and other branches of higher mathematics. In 1888 the French Academy awarded her the Prix Bordin for her researches on the top, and doubled the value of the award on account of the exceptional merit of her work. She died in 1891. The anniversary of her birth has been celebrated in the U.S.S.R., and a play based on her life, which contains many dramatic passages, is being shown in many theatres.

Possible New Industries in the British Commonwealth

Bulletin No. 4 of a new series, "Science in Industry", has recently been published under the title "Technical Knowledge as an Exportable Quantity" (pp. 22; London: Murray, Bull and Co., Ltd., 1949), and this Bulletin consists of a group of four reports on the opportunities for building up new industries in the British Commonwealth and Colonies. In the first of these, W. D. Scott and Co., of Sydney, review the chemical industry in Australia and the opportunities for chemicals in the control of pests of livestock, as weedkillers, insecticides and fungicides, in mining, food preservation, the building trades, for soap and other detergents, cosmetics, in the rubber industry, treatment of textiles, etc. In a second report, Mr. J. C. Nisbet reviews opportunities in East Africa, stressing the need for initial research and fully informed advice on technical requirements and local conditions. Ibcon, Ltd., of Bombay, review the prospects in Burma, which are poor, and in India and Pakistan, where they are good; while in the

fourth report the Industrial Research Association, Ltd., of Johannesburg, deals with industry in South Africa. This last-named country is regarded as one of great potentialities, most of the South African wool, much tobacco, as well as copper, tin, lead and other metals, being at present processed overseas. Processing of bagasse to high-grade paper, artificial wool and plastics, also offers considerable scope.

Anthropometry in Ceylon

A RECENT issue of the *Ceylon Journal of Science* (Section G, Anthropology, 4, Part 1, October 1949) contains four anthropometric studies of the peoples of Ceylon: P. K. Chanmugan compares the metrical traits of a hundred adult male subjects (fifty Sinhalese and fifty Ceylon Tamils); and H. Cullumbine discusses the muscular development, physique and stature of a total sample of seven thousand individuals in relation to age, sex, race, environment and economic status. A shortcoming of the first study is that it contains no clear reference to the technique of measurement followed, and the validity of some of the comparisons in the rather carelessly edited text, as opposed to the tables, is open to doubt. The Tamil means for weight, sitting height, hip diameter, hand length, lower leg length, foot breadth and head length are significantly greater, and for head breadth significantly less, than the corresponding Sinhalese values. There seems to be no justification for extending, as the author does, the scope of the term "Mediterranean race" to cover these two peoples, particularly in view of the brachycephaly displayed by the Sinhalese. Cullumbine's material was collected in the course of a six-month physical and nutritional survey of the population of Ceylon undertaken in 1947–48, and it has benefited much by a comprehensive and up-to-date statistical analysis. The development of the arm muscles in the two sexes attains its maximum during early adulthood and is related to differences in race, usage and occupation. That of the muscles of the leg is little affected by age or race, but varies with economic status. The effects of age, sex, race, environment and economic level on the distribution among individuals of five types of physique or body build (assessed in terms of weight and height) are estimated by the use of the χ^2 test. Although the distributions of both physique and stature are influenced by environment, racial differences persist when the environmental factor is eliminated. Physique is not significantly differentiated at the various economic levels, but a taller stature tends to be associated with a higher family income.

Magnetic Anomaly around Warsaw

A MAGNETIC survey of the magnetic anomaly in the region around Warsaw is described in No. 12 (pp. 38, 1949) of *Prace Obserwatorium Geofizycznego w Świdrze* (or *Travaux de l'Observatoire Géophysique à Swider*, to quote the French name of a publication in which a French translation accompanies the Polish text). This anomaly was among the chief of those disclosed by the Polish magnetic survey, executed by the late Prof. Kalinowski, of epoch 1928.5; but in that survey the network of points surveyed was too open to enable the detailed isomagnetic lines over the anomalous region to be drawn. At his suggestion, his daughter, now Mme. E. Kalinowska-Widomska, made a more detailed survey of the region and has recorded the tables of observations, with a series of magnetic maps, in this publication. Measurements of horizontal and vertical magnetic force (H, Z) were made with Schmidt balances at 184 stations; the work was interrupted by the Second World War, in which the variometers were destroyed, and has been completed since the War with new instruments. The survey covers a region of about 40 km. in radius, centred on Swider, and including Warsaw. The isomagnetic maps show the 1938.5 distribution of H and Z over this region, the normal course of the H and Z isomagnetic lines, and the isanomals.

A Century of Public Library Service in Britain

THE pamphlet "A Century of Public Library Service" (pp. 32; London: Library Association, 1949. 1*s.*; 10*s.* per doz.), issued by the Library Association in connexion with the celebration on August 14, 1950, of the centenary of the first Public Libraries Act, is addressed to the general public as well as to library authorities and those responsible for the day-to-day conduct of the public libraries. In view, however, of the part which some, at least, of the public libraries must play in securing the improvement in the national central scientific libraries and information services, as suggested by the Royal Society's Scientific Information Conference in 1948, the pamphlet is not without interest to the man of science and the technologist. Although one in every four members of the community uses a public library and only sixty thousand people are in areas without library services, the pamphlet shows that standards of service vary considerably, and many library services are inadequate and ill-supported; it does not appear that substantial progress has yet been made in removing the defects to which the McColvin Report directed attention in 1942. There are now 590 library authorities, with twenty-three thousand service points, twelve million registered borrowers and forty-two million books in stock, from which 294,000,000 issues were made in 1949. Expenditure in 1918, however, was only £6,710,293, and the average expenditure in 1947–48 was only 8½*d.* per head of population. Even in boroughs with a population of more than 150,000 the range of expenditure was 1*s.* 4½*d.* to 6½*d.*; in boroughs of 50,000–150,000 it was 1*s.* 5½*d.* to 3½*d.*, and in boroughs less than 50,000, 1*s.* 8*d.* to 2½*d.* In the counties the range of average expenditure was similarly varied, namely, 1*s.* 6*d.* to 3*d.* per head. The pamphlet, among its suggestions for appraising standards and the improvement of service, estimates that for a population of fifty thousand an average expenditure of 1*s.* 9*d.* per head is required for new books, apart from replacement of worn copies and older books. These suggestions claim the attention of users of the public library service, as well as of the library staff, for it is obvious that the existence of such disparities, and even anomalies, is a hindrance to the building of an effective national system of co-operation, whether in relation to scientific and technical libraries or in any other field.

Museums and Education

DR. D. A. ALLAN, director of the Royal Scottish Museum, Edinburgh, gave a lecture recently at the Royal Society of Arts on "Museums and Education" (*J. Roy. Soc. Arts*, Nov. 4). At the outset, Dr. Allan affirms that museums *are* education. They exist only to further it; they can be neither provided, maintained, nor utilized without it. Education is the preparation for living, and for living, if possible, the good and complete life. Living and learning are

inseparable. Educational methods are now demanding to an increasing extent the use of illustrative examples and opportunities for seeing things and for studying processes and their products. The museum, Dr. Allan maintains, is the obvious solution to the problem, and it is the aim of his lecture to indicate how museums can play their part in the educational scheme. A museum must first of all select and define its field. It should then portray the essential activities of man and his environment within the selected region. The need for imagination and understanding to secure an attractive display is stressed. It is also important to decide upon the type of user which it is hoped to attract, and then frame the programme and performance accordingly. Museums have a unique part to play in education, meeting the needs of both formal and informal instruction, of youth and age, of the people at home and the visitor from overseas.

Iraq Natural History Museum, Baghdad

THE first report of any newly established institution is of interest, for it usually defines policy and to a great extent indicates status. The report of the Iraq Natural History Museum, Baghdad, for 1946–49 (pp. 58; Baghdad: Government Press, 1950) covers the first three formative years and describes the inception, administration and exhibits. Opened on May 2, 1946, by H.R.H. the Regent of Iraq, the establishment of the Museum indicated a real desire by the responsible authorities for a place where the principles of natural science could be exhibited to the public and scientific research of an advanced character be pursued. The Museum is under the Ministry of Education, and its administration is directly linked with the dean of the Higher Teachers' College in Baghdad. The Museum consists of three main sections—zoology, botany and geology—and the exhibits are of a regional character. The economic and practical aspects of the oil industry are fully illustrated. An appeal for outside help in building up a reference library and collections is made in the report, which is printed in Iraqi as well as English.

Planning a Visual Education Policy

THE National Committee for Visual Aids in Education was formed to co-ordinate the work of individual teachers and of local authorities in developing visual aids on a national scale. During 1948, striking and significant progress was made in the development of visual aids in schools and colleges throughout Great Britain, and the question now is not whether to use the film and other visual aids in the classroom but rather how to use them. Throughout 1948 the National Committee was engaged in developing a policy for the growth of visual aids in education and in creating the machinery required to enable local authorities to develop in their areas the potentialities of visual aids as part of the teacher's stock-in-trade in the classroom. The formulation of this policy has involved investigations into the establishment of a suitable procedure for determination of material for production; the choice, training and secondment of expert teacher advisers to work in collaboration with film directors; the appropriate experimental scales of apparatus for different types of schools in various localities; the evaluation of the suitability of projectors on the market for use in schools and colleges; the possibility of the establishment of national, regional and local visual aid libraries; problems concerned with the carrying out of basic experiment and research on education by visual means; and the establishment of a marketing agency for the sale, servicing and distribution of visual aids.

Visual Aids and Wool

IN a lecture to the London Schools' Film Society on March 6, Mr. P. A. Wells, director of education to the International Wool Secretariat, described the use of visual aids by his organisation. The International Wool Secretariat was set up by the Statutory Wool Boards of Australia, New Zealand and South Africa in 1937 to further the uses and usefulness of wool, and its Department of Education seeks to make its work more widely known. For this purpose the Department has built up a film library of some fifty films ranging from the historical to the technical; two of these films were produced by the Secretariat. There are also eight film strips on similar subjects which, because of the greater flexibility they afford to the teacher in his choice of material, are more widely used by the Secretariat's lecturing staff in talks in schools and other institutions. The Department of Education has also produced a number of wall sheets, a photograph library and collections of samples of wool in various stages of processing.

Science in Adult Education

REFERRING to the work on "Science for Farmers" (*Nature*, **165**, 342; 1950), Mr. A. Champion, warden and resident tutor in Pilgrim College, Fydell House, Boston, Lincs, writes that similar work is being pioneered in the Holland Division of Lincolnshire by the Extra-Mural Department of the University of Nottingham, based on the University's Adult Education Centre, Pilgrim College, Boston, now in its third full year. A popular course of ten meetings on "Natural History" was launched last autumn, touching on aspects of bird and insect migration, plant and animal ecology, and plant life. A similar course ran concurrently at Spalding. Quite vigorous interest was aroused in both places. At Boston, students are approaching plant and animal ecology based on a survey of a local lake, and supplemented by work on bird behaviour at the Lincolnshire Naturalists' Association's bird observatory at Gibraltar Point, near Skegness. At Spalding the course is being related to agriculture, and deals mainly with plant structure and an ecological study of weeds on local fields. Some observation of reclaimed land is also being undertaken. Both courses have attracted keen bodies of students whose enthusiasm, especially in tackling laboratory practical work with improvised apparatus, is a real reward to their tutors. The success of the course at Boston has stimulated members of other classes in the College to seek some instruction in science, and considerable clamour has been raised for an introductory course on geology, which has now been arranged for the summer. The student body in all these courses is widely mixed: some are farmers or directly connected with agriculture, some are school teachers, but the majority have come from general interest only.

Medical Safeguards against X-Rays

HANDBOOK 41 of the United States National Bureau of Standards, entitled "Medical X-ray Protection up to Two Million Volts" (pp. 43; Washington, D.C.: Gov. Printing Office, 1949; 15 cents), supersedes Handbook 20, which was last revised in 1936. The increasing use of high-energy X-rays in

medical diagnosis and treatment has presented new problems in all phases of radiation protection; and recommended standards of safety, intended primarily for the protection of the radiation worker and not for the patient, are concisely set forth in the new handbook. Rules are given for working conditions, survey and inspection of installations (fluoroscopic and fluorographic, dental, diagnostic and therapeutic) and structural details of protective barriers, and a chapter is devoted to electrical protection. Useful tables, graphs and instructions for determining the thicknesses of protective barriers and the distances required for protection in air are included. The permissible dosage-rate is taken as 0·300 roentgen per week.

White Plaster Mould of Mushroom Beds

A SUCCINCT account of *Scopulariopsis fimicola*, a fungal competitor on mushroom beds, is to be found in Bulletin No. 16 (July 1949) of the Mushroom Growers' Association. Infection is probably brought by air-borne spores and by flies. An interesting feature is the control by addition of superphosphate —14 lb. per ton of fresh manure—or watering with 1 lb. per gallon of water.

Polymer Chemistry as Applied to Plastics

THE Plastics and Polymer Group of the Society of Chemical Industry has arranged a symposium on "Polymer Chemistry as Applied to Plastics", to be held in the Beveridge Hall, University of London, during September 21–23. Prof. E. K. Rideal will open the symposium, which will consist of four sessions as follows: September 21 (afternoon), the tools of polymer research; September 22 (morning), relationship between structure and properties of polymers; September 22 (afternoon), polymerization and polycondensation (theory); and September 23 (morning), polymerization and polycondensation (in practice). Each of the four sessions will involve the presentation of about six papers, which will be followed by general discussion, and shortened versions of the contributions will be printed and distributed beforehand to subscribing participants. The registration fee is 10*s.* to members and £2 2*s.* to non-members of the Society. Further information can be obtained from Dr. N. J. L. Megson, Hon. Organising Secretary, Ministry of Supply, Room 716, Shell Mex House, London, W.C.2.

International Federation of Electroencephalography and Clinical Neurophysiology

IN September 1949 the International Federation of Electroencephalography and Clinical Neurophysiology was formed, its objective being: "To stimulate, assist and co-ordinate research and investigation; and to improve clinical practice in the field of electroencephalography and clinical neurophysiology, to maintain close liaison with other scientific bodies or agencies and with United Nations organisations; and to provide a central clearing house for distribution of information through correspondence with the secretariat, organisation of international meetings and publication of an international journal, *Electroencephalography and Clinical Neurophysiology*". Officers of the Federation elected for the term of three years until the third International Congress to be held in the United States in June 1952 are as follows: *Honorary President*, Prof. E. D. Adrian; *President*, Dr. Herbert H. Jasper; *Vice-Presidents*, Dr. Robert S. Schwab, Dr. W. Grey Walter and Dr. Fritz Buchtal; *Secretary*, Dr. Henri Gastaut; *Treasurer*, Dr. Antoine Rémond. All correspondence should be addressed to Dr. H. Gastaut, Sec., Int. Fed. of EEG Societies, 149 Prom. de la Corniche, Marseille, France.

University of London: Appointments

THE following appointments in the University of London have been announced: Dr. M. L. Rosenheim, to the University chair of medicine, tenable at University College Hospital Medical School, from April 1, 1950; Prof. Isaac Schapera, to the second University chair of anthropology, tenable at the London School of Economics and Political Science, from October 1, 1950; and Dr. D. M. A. Leggett, to the University readership in mathematics, tenable at King's College, from October 1, 1950.

Institute for Medical Research, Kuala Lumpur

MR. JOHN W. FIELD, Institute for Medical Research, G.P.O. Box 1005, Kuala Lumpur, Federation of Malaya, states that during the Japanese occupation the Institute lost portraits of several of its former directors. It was hoped to use these in a fifty-year series of portraits for a memoir to mark the Institute's half-centenary this year. Portraits are wanted of Dr. Hamilton-Wright and Dr. Henry Fraser. Dr. Wright left Malaya in 1903 and died in Washington, D.C., in 1917. Dr. Fraser retired in 1916 to live in Scotland, where he died in 1930. Mr. Field would like to get into touch with surviving relatives.

Announcements

SIR IAN HEILBRON, director of research of the Brewing Industry Research Foundation and emeritus professor of organic chemistry in the University of London, has been appointed chairman of the Advisory Council for Scientific and Industrial Research in succession to Sir Geoffrey Heyworth, who resigned owing to pressure of other public duties.

THE Platinum Medal for 1950 of the Institute of Metals has recently been awarded to the distinguished French metallurgist, Prof. Albert Portevin, in recognition of his eminent services to the science and practice of non-ferrous metallurgy. Prof. Portevin is professor at the Ecole Supérieure de Soudure Autogène (Paris); most of his investigations have been on physical metallurgy, particularly of steels, but much of the work on foundry problems, corrosion and inclusions is equally of importance for non-ferrous alloys.

PROF. J. Z. YOUNG, professor of anatomy, University College, London, is to deliver the Reith Lectures for 1950 of the B.B.C. during the autumn; he will speak on "Doubt and Certainty in Science".

PROF. READ has been invited, as the first winner of the Cortina-Ulisse Prize (*Nature*, **164**, 605; 1949), to lecture in about a dozen Italian centres, ranging from Turin to Naples, during May. The lectures will deal with researches in organic chemistry and stereochemistry and also with certain cultural aspects of science.

ERRATUM. In the article in *Nature* of April 1, p. 517, on "World's Food and Britain's Needs", Mr. F. Le Gros Clark is reported as saying that "Agriculture has the problem of increasing output fifty to a hundred times in the next fifty years". This should read, "increasing output by 50–100 per cent".

GREGARIOUS FLOWERING OF *CHUSQUEA*

By Prof. WILLIAM SEIFRIZ
University of Pennsylvania

EARLY in the 1880's several living specimens of the slender, sprawling, mountain bamboo, *Chusquea abietifolia*, were sent from Jamaica to Kew Gardens in a Wardian case. A year or two later they flowered. Sir Joseph Hooker recorded the event as follows: "In December (1884) they suddenly burst into flower, causing me to fear that, after the manner of so many species of this remarkable tribe of grasses to which they belong, they may not survive the flowering period". Sir Joseph was correct in his fear. He investigated the matter further and made inquiry of botanists in Jamaica. Their reports fully substantiated Sir Joseph's prediction; *Chusquea* was in flower throughout the mountains of Jamaica.

The gregarious flowering of *Chusquea* in 1886 was recorded by Daniel Morris[1] in the *Gardener's Chronicle*. He said that *Chusquea abietifolia* was first noticed in flower in the autumn of 1884, flowered generally in 1885, with some laggards flowering in early 1886. It is of interest to note that the specimens in the Kew greenhouses, after transplantation to an entirely new and quite different environment many miles distant, flowered simultaneously with their former companions in the mountains of Jamaica.

In 1919 I paid my first visit to Jamaica, staying at Cinchona Gardens in the mountains. Throughout the neighbourhood, in Morce's Gap and on Blue Mountain Peak, *Chusquea* was to be found only as an entangled mat of dead plants, or as foot-high seedlings covering the banks in great number. It was obvious that the old plants had reproduced and died, and the offspring were successfully replacing their parents. I asked about a previous flowering, but no one remembered ever having seen *Chusquea* in flower. Ultimately, through the kind offices of Mr. William Harris, Government botanist, I was able to read the records of Sir Joseph and Morris in the Kingston Museum.

Sir Joseph, in remarking that *Chusquea* may not survive the flowering, "after the manner of so many species of this most remarkable tribe of grasses", was referring to a habit well known to characterize certain bamboos, namely, that of gregarious flowering after many years of purely vegetative growth. There are numerous records of the simultaneous flowering of bamboos in India, all of which read like that in the *Indian Forester* of 1901[2]: "the flowering on a large scale of the ordinary bamboo, *Dendrocalamus strictus*. The area over which the flowering extends is established at 1,200 square miles, and in this area, although a few clumps here and there have escaped, the phenomenon is universal." All dates given for the gregarious flowering of bamboos in India and China, no matter what the species, are exactly thirty-two years from the previous date. Thus, *Bambusa arundinacea* flowered in Cisgangetic India in 1804, 1836 and 1868[3]. Ancient manuscripts of China and Japan record the flowering of the slender *Phyllostachys puberla* at numerous dates, from as early as 292 B.C. down to near present times. There are numerous gaps, but all the longer intervals are multiples of thirty-two years. This thirty-two-year period is generally assumed to be the life span of the giant bamboos of India. It will be noticed that the two flowering dates given for *Chusquea*, 1885 and 1918, are thirty-three years apart.

When recording the observations which first established the life-cycle of *Chusquea*, I knew that a second observation, thirty-two years hence, would be necessary in order to establish the length of the cycle. Unfortunately, at that time I could not manage the journey, but in the late spring of last year I heard from Mr. C. Bernard Lewis, curator of the Institute of Jamaica, that *Chusquea* had flowered in certain areas; abundant seedlings now covered the slopes. On the northern side of Catherine's Peak the flowering was over, having apparently taken place "last year", that is, 1948. On June 1 Mr. Lewis wrote again that "in the region of Comfort Castle the flowering is well under way". In other regions, the flowering had not yet commenced. By the end of 1949 all flowering was over. The spring of 1949 seems, then, to have been the time of most profuse flowering. This places the second period at thirty-one years, 1918–49. There is now no doubt but that the life-cycle of *Chusquea abietifolia* is close to, if not identical with, that of those oriental bamboos which flower gregariously.

A number of interesting questions arise in connexion with the sexual rhythm of *Chusquea*: How general is it among plants? Is it always also of thirty-two years duration when not annual? Is it brought on by environmental conditions, and if so, what edaphic or climatic factor could be responsible? If not, what, then, is the determining factor; and can the cycle be disturbed? As all these questions have been considered in some detail by myself in a series of articles[3] and by numerous other investigators[4], only one or two examples which illustrate each of the foregoing questions need be mentioned here.

Life-cycles of long duration, in which there is but one reproductive period, followed by death, are not numerous among plants, nor do all the bamboos possess them. The most striking example, other than the bamboos, is the talipot palm. The palms in an avenue of *Corypha umbraculifera* in the garden at Peradeniya, Ceylon, underwent two outbursts of gregarious flowering, one of seven palms in 1918 and one of eight palms in 1922. The palms had all been planted in 1881. Here were cycles of thirty-seven and forty-one years.

The cause of gregarious flowering is, obviously, gregarious planting, either by man or by Nature. It is the precision with which the flowering occurs in a species, generation after generation, that is of interest. Most tropical gardeners attribute the precise time of flowering to drought. Man usually associates two phenomena which occur simultaneously, but rarely notices the appearance of one when it occurs without the other. It is true that gregarious flowering has occurred in times of drought, but it is just as true that the flowering has occurred when there was no drought and that there have been years of drought without flowering. The two years preceding the 1918 flowering of *Chusquea* in Jamaica were unusually wet ones.

Depletion of nutrition has been cited as a cause; but there is no evidence to support it.

Whether or not there is some rhythmic climatic cycle of long duration of which we have little knowledge cannot be definitely stated. Familiar to

meteorologists is the Brückner[5] cycle of thirty-five years, which synchronizes fairly well with the bamboo life-period; but its existence is doubtful, though it was early noted by none other than Francis Bacon, who wrote: "There is a toy which I have heard. . . . They say it is observed . . . that every five and thirty years the same kind and suit of years and weathers come about again . . . computing backwards, I have found some concurrence."

The reality of a thirty-five-year climatic cycle is not our main problem, but rather, if it is real, does it determine the life-span of certain plants, and if so, what is the factor? Aside from temperature and moisture, there is light, the daily duration of which has, in work on photoperiodism, been shown to have a remarkable effect on flowering.

It must be granted that environmental factors do influence a plant's behaviour, but there is no conclusive evidence that they determine a life-span such as the thirty-two-year cycle of *Chusquea abietifolia*, any more than they determine the supposed three score and ten years of human life. The factor responsible for the normal length of life of an organism lies in the protoplasm of the species.

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RECORDS OF BRITISH ENTEROPNEUSTA

By C. BURDON-JONES

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SINCE the early records of *Saccoglossus ruber* (Tattersall)[1], and *S. serpentinus* (Assheton)[2], two definite species, *S. cambrensis* (Brambell and Cole)[3] and *S. horsti* (Brambell and Goodhart)[4], have been fully described and a further, as yet undescribed, member of the genus *Protoglossus*[5] has been recorded from the British Isles. An investigation of the group with particular reference to the systematics, their habits, distribution, spawning and life-history, was begun in 1945. Recently, Newell[6] and Purchon and Jefferson[7] have recorded Enteropneusta from Great Britain.

In August 1948, Assheton's original collecting grounds on the Island of Mull off the west coast of Scotland were visited. It is interesting to record that now, forty years later, *Saccoglossus* still flourishes there. A few large specimens, notably larger than those afterwards discovered, were found on what seemed to be the original site. They were confined to pockets of sand in among coarse gravel. This led to the exploration of the neighbouring sandy shores and the subsequent discovery of the main bed within two miles of the mouth of the River Aros, whence *S. serpentinus* was probably collected by Assheton. Although several other likely shores of the Sound were examined, not one yielded any further specimens, neither did any of the shores of the neighbouring islands of Ulva and Iona. It seems, in consequence, that the species is confined to one main bed covering about an acre of the shore between low water neaps and low water springs, with a few strays attempting to colonize other seemingly less favourable habitats. As many as 112 casts per square metre were counted at the most densely populated points on this main bed. The location suggests that these specimens belong to the species described as *S. serpentinus* by Assheton. Yet externally they are indistinguishable from *S. cambrensis* and the habitat is similar. Dr. H. A. Cole was fortunately with me at the time and agrees with this opinion.

Should these two species prove to be identical, then Assheton's original description was far from adequate to enable the species to be identified with certainty. Brambell and Cole concluded provisionally that *S. ruber* and *S. cambrensis* were distinct species, in the absence of an adequate description of the former, but pointed out that the resemblances are close and that the two species are more nearly akin to each other than to any other known species. Elmhirst[8] recorded fragments of *S. serpentinus* in dredgings from the Clyde and "undoubted specimens" of *S. ruber* dredged off Cumbrae and near Loch Striven. In view of the inadequacy of the available descriptions of these species, these identifications would seem questionable. It would appear possible that the reinvestigation of all three species, *S. ruber*, *S. serpentinus* and *S. cambrensis*, may show that they are really one. *S. cambrensis*, since its original discovery in the Menai Straits, has been recorded from various points along the coast of Anglesey and from one point on the Lleyn Peninsula; now Purchon and Jefferson[7] record it from Pembrokeshire. If the species from the west coasts of Ireland and of Scotland should prove to be the same, then it has a far wider distribution than at first supposed.

It is interesting to note, in connexion with this question of distribution, that Newell[6] has recorded *S. kowalevskyi* Agassiz (?), from Whitstable. His identification was based on external characters only and is tentative. He very kindly sent the preserved specimens to me and, on careful examination and comparison with specimens of *S. kowalevskyi* and *S. horsti*, I am inclined to identify them provisionally as *S. horsti*, but this identification is subject to confirmation when the material has been sectioned. The shell gravel and sand from which Newell obtained his specimens is, in my experience, a more typical habitat than the one from which it was originally described by Brambell and Goodhart. The species has, however, been found in a variety of habitats, but a sandy one seems the most favourable. Geographical evidence is also strongly in favour of it being *S. horsti*, since Whitstable is only 190 miles from their original source, whereas all previous records of *S. kowalevskyi* are, with one exception, from the other side of the Atlantic Ocean. The exception is the record by Caullery and Mesnil[9] of a fragmentary specimen which these workers found at low water spring tides at St. Martin, near Cap de la Hague. They identified the species on characters which are also common to *S. horsti*. It would thus seem probable that both the Whitstable and Cap de la Hague specimens should be ascribed to *S. horsti*.

These records cast quite a different light on the distribution of the British Harrimanidæ, which has hitherto been thought to be very localized. Work by Davis[10] on the American species *S. pusillus* Ritter and my recent work on the life-history of *S. horsti* throw further light on the way in which this distribution might be attained. In both species a definite planktonic phase was observed in the course of larval development. It is also known that, for the latter

species, the duration of this phase may be greatly modified under certain conditions. Such a phase must inevitably influence the distribution, since the animals are confined to burrows for the major part of their existence. Yet another point should be noted here. A mass spawning of *S. horsti* was observed in the Solent on May 15, 1949; the phenomenon was confined to the ebb of the evening spring tide. There had been no indication of spawning on the preceding days, nor was it repeated on the following days. The spawn was lying on the surface of the sand around the mouths of the burrows and would inevitably have been widely dispersed by the incoming tide.

Further details of the investigations outlined above, along with an account of the life-history and organogenesis of the larval *S. horsti*, will be published shortly.

I am indebted to the Browne Research Fund of the Royal Society for a grant which made the major part of this work possible.

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THE CO-ORDINATE LINK IN CHEMISTRY

By Dr. J. CHATT

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EVIDENCE that the co-ordinate link may sometimes be represented more accurately by a double bond has been advanced by Phillips, Hunter and Sutton[1] to explain the observed low dipole moments and short interatomic distances in such substances as the phosphine oxides, and by Pauling[2] to explain the observed short interatomic distances in the metal carbonyls, nitrosyls and complex cyanides. That these effects are capable of other explanation has been shown by Wells[3]; yet on chemical grounds alone it appears that co-ordination occurs by two types of bond: (1) the classical co-ordinate link; and (2) a bond typified by the co-ordination of the olefines, for the formation of which it appears that *d* electrons from the metal as well as two electrons from the ligand are necessary.

The compounds BX_3 (X = F, CH_3 and H) are noted for the great variety of complex compounds they form, yet $BF_3.PCl_3$ decomposes at above $-6°$ C.[4], $CO.BH_3$ at well under room temperature[5], and $B(CH_3)_3$ shows no sign of association with C_2H_4 either in the gaseous or liquid phases[6]. On the other hand, phosphorus trichloride and carbon monoxide form complexes with platinous chloride stable up to and above 250° C.[7], and ethylene platinous chloride $(C_2H_4PtCl_2)_2$ decomposes at 190–200° C.[8]. This striking difference in the stabilities of these two series of complex salts has to be contrasted with the high stability of the amines in both series.

I have now attempted to make complexes using phosphorus trifluoride as ligand. On mixing boron trifluoride with phosphorus trifluoride no combination occurred, even when the gases were cooled to $-80°$ C. This inability to combine is not a property of phosphines in general, because on passing BF_3 through a petroleum ether solution of *n*-propyl phosphine the solid co-ordination complex was immediately precipitated.

The behaviour of phosphorus trifluoride with platinous chloride was very different. By passing phosphorus trifluoride through a plug of the powdered chloride in a tube heated to 200° C., $(PF_3)_2PtCl_2$ was readily produced as a white crystalline sublimate, melting point 102° C., in the cold part of the tube. This is a most remarkable complex. It may be boiled under reflux in a dry atmosphere at atmospheric pressure with only slight deposition of platinum. Phosphorus trifluoride is lost and the temperature of the vapour rises from 240° to 285° C. as conversion to the red $(PF_3PtCl_2)_2$ occurs. At this higher temperature deposition of platinum takes place rapidly. In general behaviour, these complexes resemble the corresponding carbonyl platinous halides which were hitherto the most volatile platinum compounds known. Unfortunately, these fluoro complexes are avidly hydrolysed by moist air with the production of hydrogen fluoride; this makes a study of their chemical properties difficult.

A second difference between the two series of complexes is indicated by Hel'man[9], who has shown that both ethylene and carbon monoxide in their platinous complexes are characterized by producing a lability in the group *trans* to themselves. Thus any second substituent is directed exclusively into the *trans* position, from which it may also be readily removed. Ammonia and primary amines direct entirely into the *cis* position, and the second substituent is not exceptionally labile.

We are thus presented with two distinct series of neutral ligands capable of forming very stable complexes: (1) typified by ammonia and primary amines which form stable complexes with both the boron compounds and platinous chloride, and which are *cis*-directing in their platinous complexes; (2) typified by ethylene, carbon monoxide and phosphorus trifluoride, the boron complexes of which are non-existent or very unstable, but the platinous complexes of which, by contrast, are stable to 180–300° C., and these ligands are *trans*-directing in their platinous complexes.

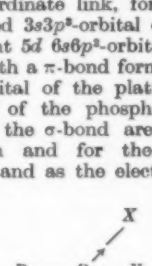
The lone-pair theory of co-ordination does not explain why phosphorus trifluoride and trichloride should behave so differently towards boron trifluoride as compared with platinous chloride. We know that boron trifluoride can form complexes only by a two-electron bond to keep within the covalency maximum for four, so it cannot co-ordinate other than by the mechanism of the lone-pair theory. It is thus not surprising that ethylene, which has no lone-pair, and phosphorus trifluoride, where the availability of the lone-pair is so much reduced by the exceptional electron-attracting power of the fluorine atoms, do not form complexes with tricovalent boron. This is entirely in accordance with the lone-pair theory.

On the other hand, the very high stability of the corresponding platinous complexes suggests, either that co-ordination in the platinous series is by some entirely different mechanism, or that the donation of the lone-pair is supplemented by a mechanism of an

exactly opposite character—a mechanism which would be enhanced by the large inductive effect of the fluorine atoms—and is impossible in the formation of complexes by boron trifluoride.

The second suggestion seems the more probable, because, if we accept Pauling's supposition that unhybridized *d*-orbitals can take part in valency formation, these striking differences between the co-ordination chemistry of platinous chloride and tricovalent boron can be explained in a simple qualitative manner.

In the platinous complexes we have a σ-bond Pt-P, the classical co-ordinate link, formed by the combination of a filled $3s3p^3$-orbital of the phosphorus atom and a vacant $5d\ 6s6p^3$-orbital of the platinum atom, together with a π-bond formed by the overlap of a *filled* 5*d*-orbital of the platinum atom and a *vacant* 3*d*-orbital of the phosphorus atom. Thus the electrons for the σ-bond are supplied by the phosphorus atom and for the π-bond by the platinum atom; and as the electronegativity of *X*



increases, the drift of electrons forming the π-bond will partially neutralize the inductive effect of the atoms *X*. The availability of the lone-pair for σ-bond formation will thus not be impaired to the same extent as in the absence of a π-bond, so that in practice we find that the stability of the complex is not greatly affected by the electronegativity of *X*. In the boron series, where no *d*-electrons are available, we observe only the decreasing strength of the σ-bond as *X* increases in electronegativity from the stable tri-*n*-propyl phosphine complex through the weakly bound phosphorus trichloride complex, culminating in the complete disruption of the bond in such non-existent compounds as $BF_3.PF_3$.

A parallel suggestion has already been made with reference to the carbonyl compounds, where a secondary interaction is suggested between the *d*-orbital of the metal and the π-bonds of the carbon monoxide molecule[10]. It is not so easy to see how the two carbon atoms of the ethylene molecule can be bound by a π-bond to the platinum atom, but the mechanism of bonding has undoubtedly many similarities to that of the carbonyl[6].

Thus there is direct chemical evidence available to demonstrate that the lone-pair theory is inadequate to explain co-ordination to the heavier transition and neighbouring metals, particularly of platinum, and this evidence tends to support the conclusions of Pauling[2] and Phillips, Hunter and Sutton[1], based on physical measurements capable of less direct interpretation.

It will be interesting to see whether phosphorus trifluoride can replace carbon monoxide entirely from the volatile metal carbonyls without altering their character, and also to compare the behaviour of phosphorus trifluoride with that of nitrogen trifluoride where there are no vacant 2*d*-orbitals, so that π-bonding could not enhance the stability of the platinous complex. A suitable name for such a π-bond is a 'dative π-bond', and the bond as a whole may be called a 'dative double-bond', to distinguish it from the ethylenic double-bond where the paired electrons are supplied equally by each atom.

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GOVERNMENT RESEARCH IN AUSTRALIA

FINAL REPORT OF THE COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

THE twenty-second—and last—annual report of the Council for Scientific and Industrial Research, Australia*, covers the year ended June 30, 1948, since when, on May 19, 1949, the Council has been replaced by the Commonwealth Scientific and Industrial Research Organisation (see *Nature*, April 30, 1949, p. 671, and August 6, p. 223). The first annual report of the latter body, for the year ended June 30, 1949, has already been tabled in the Australian Parliament. The formation of the new Organisation was also accompanied by the retirement of Sir David Rivett after twenty years of service as chief executive officer and more recently as chairman, and also of Dr. A. E. V. Richardson, who succeeded him in the former post.

During the course of the year ending June 30, 1948, the status of the Section of Tribophysics was changed to that of a Division, and during the year a site was acquired at Geelong for a Division of Wool Textile Technology. A study was made of the wool carbonizing process; pilot plant was being constructed for the study of solvent degreasing, and investigations were extended to include biochemical studies of the protein structure of wool, electron microscopic studies of the wool fibre and the keratin molecule, and work on wool wax. The Council also assisted financially the work of the British Wool Industries Research Association at Torridon, Leeds. At the request of the Northern Australia Development Committee, the Council undertook a soil and vegetation reconnaissance survey of the most favourable parts of the northern areas. The possibility of an irrigation programme in the Kimberley–Ord River region of Western Australia was also investigated, and a regional headquarters laboratory was established at St. Lucia, in association with the University of Queensland, where facilities will be available for studies on general soils, crops and pastures.

The Council, besides giving further attention to the problems of the utilization of coal, commenced work on the microstructure of coal in collaboration with the Botany Department of the University of Melbourne, and a Coal Survey Section was established to assist in preparing a comprehensive survey of the physical and chemical properties of coals from all the main Australian coal-fields. During the year the

* Parliament of the Commonwealth of Australia. Twenty-second Annual Report of the Council for Scientific and Industrial Research for the Year ended 30th June, 1948. Pp. 141. (Canberra: Commonwealth Government Printer, 1949.) 8*s*.

Australian Leather Research Association was established, and this Association was supported by the Council with a grant equal in amount to the total money it spent on scientific research, up to a maximum of £5,000 a year.

In collaboration with the Australian National Research Council, the Council also undertook responsibility for a new scientific quarterly, the *Australian Journal of Scientific Research* (see *Nature*, **162**, 210 and 808; 1948), while special reference is made in the report to the collaboration of the universities in the Council's investigations. The staff difficulties of the Information Section were somewhat mitigated, and the main trend of the work of the Section showed a greater emphasis on the solution of technological inquiries. Ninety-six bibliographies and summaries of information were prepared during the year, and the systematic preparation and circulation of contents sheets and summaries of Russian scientific periodicals were continued, in addition to both oral and formal translation work. Films entitled "Northern Australia Reconnaissance Surveys" and "Irrigation Research N.S.W." were released during the year, and six others were in the course of production. The Library was maintained as a system rather than a library unit, the union catalogue at the head-office library providing the main connecting link. Besides lists of scientific and technical staff and of personnel of the Council and its committees, a list of publications during the year, arranged under divisions, is appended to the report.

Reviewing the work of the different divisions, the report notes that progress was made by the Division of Plant Industry in developing new disease-resistant lines of potatoes, and work continued on the establishment of various pasture species when sown with cereal crops, on the field germination of subterranean clover and its response to molybdenum, on the trial of foreign grasses and legumes, and on the fertilizer requirements of the three main soil-types. Besides work on mineral deficiency and on natural pastures, the Division investigated a number of plant diseases and their control by chemical means, as well as the effect of plant-growth regulating substances. The results of soybean trials were conflicting; but progress was made in the use of opium poppy for morphine, *Duboisia* spp. as sources of hyoscine and atropine, and more particularly in the survey of native plants for sources of pharmacological substances and the investigation on the occurrence of rutin in *Eucalyptus macrorrhyncha*. An extended programme continued on tobacco plants, tomatoes and tomato hybrids, beans resistant to bacterial blights, and the witches' broom disease of lucerne.

The Division of Economic Entomology reports that control of St. John's wort by introducing insect enemies continued to fulfil its early promise. The great value of pentachlorophenol in the preservation of timber from termite attack was demonstrated, and comprehensive investigations on the control of insect pests of cabbages showed that the most effective means of control is an all-purposes combination dust or spray containing D.D.T. and an aphicide. Two major expeditions were organised by the Division to study the distribution of injurious insects and to collect material for taxonomic study. Much difficulty is reported in animal health and production investigations; but at the Animal Health Research Laboratory, Melbourne, the experiment on the influence of nutritional stresses on immunity against pleuropneumonia of cattle was concluded, and extensive trials were carried out with penicillin in mastitis of dairy cattle. Studies on phenothiazine, an anthelmintic, were continued at the McMaster Animal Health Laboratory, and other anthelmintics were tested against *Paramphistomum* spp. in sheep. Sheep dipping, the blowfly-strike problem and the bionomics of the foot-louse of sheep also received attention, while at the McMaster Field Station investigations on the inheritance of skin wrinkles and polledness in sheep were concluded.

Five years of experimental work by the Division of Biochemistry and General Nutrition finally proved that appropriate manurial treatment with superphosphate containing zinc and copper would allow good permanent pastures to be established on tracts in South Australia deficient in copper, zinc, molybdenum, etc., and it is estimated that in this way at least three thousand square miles of practically useless terrain can be developed. The correlation between wool production and nutrition of sheep, and the processes of rumination and vitamin A requirements of sheep were also studied. The demand for examination of areas for land settlement appeared to be diminishing, and more of the time of the Division of Soils should be available for studies in pedology and for soil problems of a physical, chemical or microbiological nature. The reports of the Soil Chemistry and Soil Physics Sections, the Soil Microbiology Section and the Soil Physics and Mechanics Section record much useful work.

At the Commonwealth Research Station, Merbein, where the staff was built up to above the pre-war level, investigations were initiated on the major problems of the irrigated lands of the middle and lower Murray, the economic plants of these areas, and the processing and care of the products, while at the Irrigation Research Station at Griffith field experiments with orange trees, on the usage of water in rice fields, on the movement of water in furrows and on drainage were conducted. Forest products investigations ranged over the structure of wood, wood chemistry, timber physics and mechanics. Food preservation investigations continued on the same lines as the previous year, but studies were also initiated on a new type of louvred van for the long-distance transport of fruit and vegetables, and on the freezing of fruit and vegetables, while fish preservation investigations were scheduled for extension by the opening of a small branch laboratory at Eden. Fruit dehydration investigations were widened to include treatment with sugar before dehydration.

The reorganisation and equipment of the Fisheries Division to undertake a comprehensive research programme was largely completed during the year, and in addition to the fisheries research vessel *Warreen* operating in Western and South Australian regions, the *Liawanee* was due to be chartered for investigations, chiefly on barracouta, school-shark and crayfish, in the Tasmanian region, while off the south-eastern continental coast increased use would be made of the *H. C. Dannevig* on the trawling grounds. A survey of the fishery resources of Papua – New Guinea was commenced with the *Fairwind* in May 1948. Much advisory work was conducted by the Division, but research on agar was suspended, although the search for new seaweed beds continued.

Industry showed a marked readiness to approach the Division of Metrology for advice and assistance in the calibration of equipment, and the position improved with regard to the basis of all measurements of length, and more particularly volumetric

standardization. The Division of Electrotechnology, too, made considerable progress in establishing further electrical standards and extending the scope of its measuring facilities.

The Division of Physics continued its policy of increasing the amount of fundamental research as compared with short-term technical investigations, progress being recorded on the studies of the formation of rain, on the solar atmosphere and other phenomena; but staff shortage was a severe handicap. The Heat and Light Sections concentrated their attention on the phenomena of ice crystal formation and the attainment of very low temperatures, and on photometry respectively. Aeronautical investigations under the new Aeronautical Research Committee dealt with aircraft structures, properties of alloys, gas-turbines and high-speed flow. In the Division of Industrial Chemistry, pilot tests of a new process for the production of chromic anhydride from chrome iron ore by an acid digestion method were completed, and work on monazite, rutile, zircon and uranium ores continued, as well as on the deterioration of concrete. Among many other investigations may be cited those on Australian substitutes for linseed oil, the use of long-chain carbon compounds in the differential flotation process and detergents in wool scouring. In radiophysics the chief features of the year were work on radio-frequency emissions from the sun, cosmic noise, the ionosphere and the use of radar for surveying and navigation.

The Division of Tribophysics studied the nature of the forces restraining the movement of clean metal surfaces over each other, and the physical and chemical properties of the films of molecular dimensions used as boundary lubricants. Other departments which recorded satisfactory progress during the year are the Building Materials Research Section, the Dairy Products Research Board, and the Section of Mathematical Statistics. The report also refers briefly to research work in the Atomic Physics Section, and on the growth and rubber content of the guayule plant under Australian conditions.

VOYAGE OF THE ROYAL RESEARCH SHIP *DISCOVERY II*

THE Royal Research Ship *Discovery II*, at present in the West India Dock, Port of London, is to sail shortly on a voyage of deep-sea research, mainly in the Southern Ocean and Antarctic. This follows the departure in January of the Royal Research Ship *William Scoresby* on a ten-month voyage for investigations on oceanography and whales in South African and Australian waters (see *Nature*, January 21, p. 105). The two ships have independent programmes; but their work for the present is principally in continuation of the Discovery Investigations, formerly under the Colonial Office and now transferred to the Admiralty as a part of the National Institute of Oceanography.

The main purpose of the voyage of the *Discovery II* is to round off a general oceanographical survey of the Southern Ocean which had been nearly completed by the former Discovery Committee before the Second World War. This survey is important for two reasons: first, it gives the necessary background to investigations on whales and other oceanic life in the far south with which the Committee was specially concerned, and secondly, it is itself an important step forward in the exploration of the oceans and will give opportunities for carrying out many special investigations of basic importance to the science of oceanography.

There is a relative simplicity in the water circulation and distribution of life in the Southern Ocean, so that generalizations can often be made from fewer observations than in other regions, and principles can be established which apply to all oceans. The voyage is to last about a year and a half, and the ship will work mainly in the Indian, Australian and Pacific sectors of the Southern Ocean between subtropical waters and the fringe of the pack ice. The work, however, will not be confined to these regions, for on the outward voyage a line of deep-sea observations will be made in the little-known central Indian Ocean. The scientific work of the voyage will begin in earnest when the ship leaves Colombo and steams southward on the meridian of 90° E. At regular intervals the ship will be stopped on station, and temperature, density and chemical constituents of the water will be ascertained from the surface to the bottom, and the plankton from the surface to a depth of about 1,500 metres. The ship will call at Fremantle in July and then complete the same line of stations in the Indian Ocean, southwards to the pack ice. Thereafter she will work eastwards, carrying out similar work between ports in Australia and New Zealand and the Antarctic. These lines of deep-sea stations form the essence of the whole programme. Taken with the work done before the War, they will provide a network of observations covering the whole Southern Ocean, from which the main water-masses and currents and the various forms of oceanic life can be mapped out not only horizontally but also in vertical sections.

Many subjects will receive special attention during and between the principal lines of stations. Echo soundings will be taken wherever the ship goes, sometimes with the continuous recorder; deep cores of the sea bottom will be taken from time to time by the method used in the recent Swedish expedition in the *Albatross*, and some measurements of the depths of ocean sediments will be made with the seismic sounding-apparatus developed in recent years. Direct observations will be made on the distribution and habits of whales, and on seals, fish and birds according to opportunities. The 'convergences'—certain surface boundaries between important water masses—will receive attention, the seasonal distribution of pack ice will be studied, and there may at a later stage be opportunities to examine and chart a little-known part of the Antarctic coast.

Other work includes soundings and amendments to charts for the Admiralty Hydrographic Department, routine observations for the Meteorological Office and physiological work for the Royal Naval Personnel Research Committee.

The *Discovery II* is an oil-burning steamship of 1,036 tons (gross), specially designed as a research ship, and with some protection against ice. She was built in 1929, but in recent months has undergone an extensive refit, and is now supplied with very comprehensive equipment for deep-sea research. Her total complement is about fifty-six officers and men, including four scientific officers and three assistants. Dr. H. F. P. Herdman is the senior scientific worker in charge of the work at sea, and Commander J. F. Blackburn is in executive command. Dr. N. A. Mackintosh, director of the Discovery Investigations, will sail with the ship for the first part of the voyage.

SMITHSONIAN INSTITUTION

ANNUAL REPORT FOR 1948–49

THE report of the Secretary of the Smithsonian Institution for the year ended June 30, 1949*, again refers to the shortage of staff and of adequate housing space, which continues to hamper the activities of the Institution. During the year the Wright brothers' aeroplane of 1903 was presented to the United States National Museum (see *Nature*, 162, 646; 1948), and plans for the National Air Museum envisage a special area for this exhibit. Approximately 446,000 specimens were added to the collections of the Museum during the year, while field work was conducted in Arnhem Land (North Australia), India and Nepal, the Persian Gulf and the Red Sea, New Zealand, the Canadian Arctic and in South and Central America, as well as in the United States. Some notes of this field work, which included anthropometric measurements of Mayan-speaking Indians in the highlands of Guatemala, ornithological survey in the eastern section of the Province of Panama, botanical work in the north-west of the Argentine, and in New Zealand, and a special study of the ecology of the lichens of the Arctic slopes of Brooks Mountains in northern Alaska, are given in the Director's report.

The daily attendance at the National Gallery of Art averaged 4,225, and nearly a thousand problems requiring reports were investigated. In a continuation of his archæological work in Panama, the Director of the Bureau of American Ethnology found hitherto undescribed ceramic cultures at Utivé and Barriles and obtained much new information on the classic Chiriqué and Veraguas cultures. Dr. E. R. Willey completed his monograph "Archæology of the Florida Gulf Coast", and this is being published by the Institution. Of 2,107 archæological sites located and recorded by the River Basin Surveys, 456 have been recommended for excavation or testing.

The Smithsonian International Exchange Service handled 840,125 packages of publications, an increase of 80,006 on the previous year, and shipments are now made to all countries except Roumania, while fifty-eight full and thirty-eight partial sets of United States official publications are sent abroad in exchange for similar publications of other countries. At the close of the year the National Zoological Park contained 3,724 specimens, an increase of 927 on the previous year, while the number of visitors reached a record of 3,346,050.

Tests at the three most promising sites for a new high-altitude solar observatory indicate that the best skies prevail at the Clark Mountain site, California, with Pohakuola, Hawaii, ranking next; but lack of funds have necessitated postponement of building operations. The special radiation measurements started in 1945 at Camp Lee, Virginia, were continued, as well as those at Miami and Montezuma. The Division of Radiation and Organisms was occupied chiefly with reorganising and re-equipping the laboratories. In the Canal Zone Biological Area in Panama, twenty-nine men of science from different organisations worked at the laboratory on such subjects as the metabolic reactions to temperature in various animals and plants, long-term termite-resistance tests and the effects of tropical conditions on photographic equipment and materials, including colour film.

Among the outstanding publications of the year were Dr. H. Field's "Contributions to the Anthropology of the Soviet Union" in the Smithsonian Miscellaneous Collection, two more volumes in the series of life-histories of North American birds by A. C. Bent, and a paper by J. R. Swallen on new grasses of South and Central America, in Contributions from the United States National Herbarium. The Smithsonian Library received 57,671 publications during the year, as well as 17,713 periodicals, mostly in exchange from research institutions and other scientific and educational institutions. Inter-library loans totalled 2,619 to eighty-nine libraries, and 338 new exchanges were arranged. Of the library's holdings of 921,206 volumes, more than half are housed in the Library of Congress as the "Smithsonian Deposit". The usual departmental reports and the financial report of the executive committee of the Board of Regents are appended in this annual report.

* Report of the Smithsonian Institution and Financial Report of the Executive Committee of the Board of Regents for the Year ended June 30, 1949. (Publication 3992.) Pp. ix+149. (Washington, D.C.: Government Printing Office, 1950.) 45 cents.

FREEDOM AND CO-ORDINATION

OF independent means, Mary P. Follett was a native of New England who was educated partly in the United States and partly at Cambridge. For a number of years she was engaged in voluntary social work but then turned to the study of government. She soon found much more vitality in thought and feeling among business men than among politicians and economists, and gave more and more attention to business administration. The rest of her life was spent in lecturing and writing on that subject, and the philosophy she evolved has had a considerable influence on efficient management practice in her own and other countries. She died in 1939, and the present volume is mainly made up of a series of lectures given in that year at the London School of Economics (Freedom and Co-ordination: Lectures in Business Organisation. By Mary Parker Follett. Edited, with an Introduction, by L. Urwick. Pp. xvii+89. London: Management Publications Trust, Ltd., 1949. 5*s*. net).

Briefly stated, Mary Parker Follett's belief was that 'arbitrary' authority over others, in which orders are given by those at the top and executed by their subordinates, is wrong both in theory and practice. Authority should rest in an individual's function in an organisation, and orders issued by him should emerge from the "law of the situation" rather than by any desire to exercise power. Instead of the system whereby some are placed "in charge of" others, Miss Follett advocated that leaders should be regarded as those who can achieve a synthesis of all the different points of view in a given situation. Such a process of co-ordination will lead to a more effective control of the organisation, and if more attention is paid to realities than to the unsupported opinions of those holding high positions, the agreed authority will command universal respect.

Although it is doubtful that a situation in which there are deep cleavages of opinion on fundamentals can always provide the solution which Mary Follett believed will emerge by discussion, her stimulating approach to administration commands wide respect, and the editor, Colonel L. Urwick, has performed a useful service in making this latest record of her thought available to British readers.

T. H. HAWKINS

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

A Dielectric-Constant Method for Following the Non-Stationary State of Radical Reactions

MUCH of the recent development in the kinetics of chemical reactions has been concerned with the absolute evaluation of rate constants for the elementary reactions comprising a complex process. This has been carried out mainly indirectly in photo-reactions, using intermittent radiation to determine the life of the radical or chain concerned in the rate-controlling step. It would, however, be much more desirable in such reactions to be able to determine these life-times directly, by delineating the rise in concentration of a radical following the commencement of irradiation and the corresponding decay when irradiation is stopped. This can be done in principle, given a method of detecting reaction which is both highly sensitive and also very rapid in response, since life-times may be as short as 10^{-3} sec. These stringent requirements have now been met in the case of the liquid-phase polymerization of vinyl compounds by the construction of an instrument for following the change in dielectric constant which accompanies the reaction. This instrument has a sensitivity of 1 part in 10^8 of dielectric constant and a response time of 10^{-4} sec.; the frequency of operation is 50 Mc./s. We are indebted for the design of the instrument to Dr. C. M. Burrell, of the Radar Research and Development Establishment, and to the Ministry of Supply for invaluable help in its construction.

The polymerization, which is exothermic, is carried out adiabatically, and the amount of reaction is determined from the resultant fall in dielectric constant; a correction is applied for the second-order increase in dielectric constant due to the accumulation of polymer. The sensitivity to polymer formation is of the order of 1 part in 10^7. A convenient illustration of the method is provided by the polymerization of pure vinyl acetate photosensitized by α-azo-*bis*-*iso*-butyronitrile ($NC.(CH_3)_2C.N.=N.C(CH_3)_2CN$); the method has also been used for styrene, methyl acrylate, etc. Two techniques are used to evaluate the life-times of the radicals. In the first, the light is switched on and the approach to the stationary state is delineated; when this state has been attained, the light is switched off and the decay of the reaction is also delineated. An oscilloscope trace of this sequence of events is shown in Fig. 1. It can be shown[1] that the life-time (τ) of the kinetic chain in the steady state is given by $t/\ln 2$, where t is the intercept on the time axis of the linear portion of this curve. Similarly, τ can be evaluated from the decay of reaction when the light is cut off.

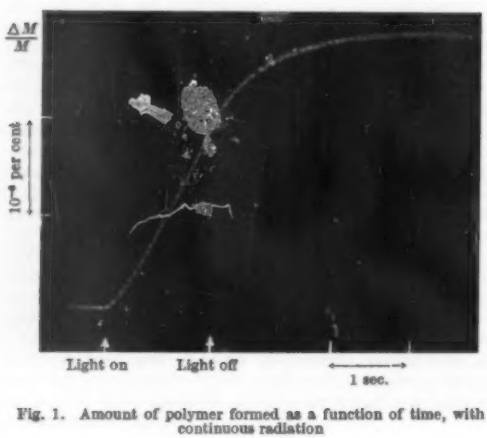

Fig. 1. Amount of polymer formed as a function of time, with continuous radiation

In the second method, a brief flash of intense radiation from a 'Sieflash' tube is admitted to the system so that decomposition of a fraction of the sensitizer is complete before polymerization starts. The subsequent growth of polymer radicals is then observed directly on the oscilloscope. The average life of the radicals is again determined from the shape of this curve. A typical trace is shown in Fig. 2.

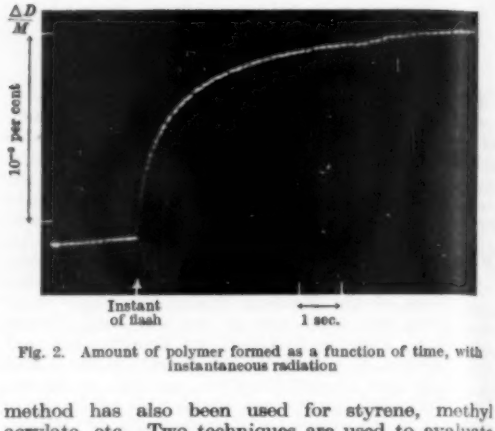

Fig. 2. Amount of polymer formed as a function of time, with instantaneous radiation

	Rate (%/hr.)	τ exp. (sec.)	τ calc. (sec.)
Continuous illumination	5·8	0·29	0·09
" "	2·0	0·73	0·26
Flash illumination	5·8	0·2	0·09
" "	2·5	0·4	0·20

The results of a series of experiments are given in the accompanying table. The rates of polymerization are calculated on the basis that the heat of polymerization of vinyl acetate is 17 k.cal. per mole, and may require to be revised later. Alongside the experimental life-times are given the life-times for the rates concerned derived from the values of the growth and termination coefficients given by the method of intermittent illumination[2]. It will be seen that the results are in reasonably good agreement, having regard to the difference in the techniques employed.

A full description of the apparatus and results will be published later.

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[1] Symposium on Combustion and Explosion, Wisconsin (1947).
[2] Burnett, G. M., Valentine, L., and Melville, H. W., *Trans. Farad. Soc.*, 45, 960 (1949).

Discrimination of Pitch in Short Pulses of Sound

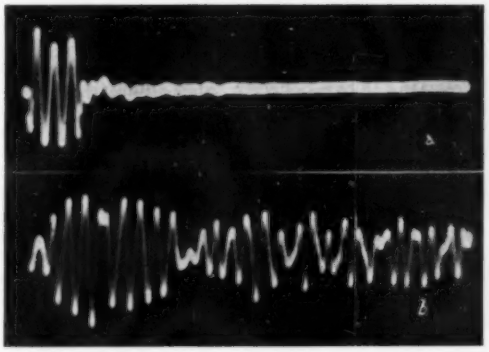
It has been observed, when using short pulses of tone for echo-location in auditoria, that pulses which are too short to give any clear impression of pitch when heard directly from a loudspeaker seem to assume a more definite pitch when radiated into an auditorium. One of us mentioned this point at a recent meeting of the Acoustics Group of the Physical Society, and, as several contributors to the discussion questioned the effect, it is thought that this account of controlled tests will be of interest.

Subjects were asked to adjust an audio-frequency oscillator to the same pitch as that of given pulses of tone, both sounds being received on high-quality earphones and selected at will by a change-over switch. The pulses, provided by a second audio-frequency oscillator in conjunction with a pulse-forming amplifier, were fed to the earphones through four different channels. One channel consisted simply of a variable attenuator, and the other three consisted of similar loudspeakers and microphones in a 'dead' sound measurement room, a normal talks studio, and a reverberation room respectively. The pulse repetition-rate was set at approximately 1 sec., and the length adjusted at each frequency first to 3 cycles, and afterwards to 6 cycles of a given tone. Tests were carried out at six fixed frequencies, and ten subjects took part. The dials of both oscillators were invisible to the subject.

The results were presented as percentage deviations, $|\delta|$, from the true frequency. Plotting on probability paper showed that the distribution of results up to ± 25 per cent was approximately Gaussian, but the distribution of the small number of errors greater than 25 per cent rapidly became rectangular. This was taken to mean that errors less than 25 per cent were more or less successful attempts to match a recognizable pitch, whereas those greater than 25 per cent represented inability to recognize any pitch at all. These latter were, therefore, noted as 'misses' and excluded from the analysis of the rest.

	Direct	Reverberant	S.D. of difference
3-Cycle pulses			
Mean of $\|\delta\|$, all results	13·3	10·35	—
Mean error as percentage of subject's aggregate	28·5	21·7	3·7
Number of misses	31	17	—
6-Cycle pulses			
Mean of $\|\delta\|$, all results	6·73	5·07	—
Mean error as percentage of subject's aggregate	30·7	19·7	3·8
Number of misses	14	7	—

As no correlation between error and frequency could be found, the mean result for the six frequencies was calculated for each subject under each of the eight conditions. Different subjects showed widely different abilities to match the frequencies of pulse and reference tone, and the means were therefore expressed as percentages of the subject's aggregate score for 3- and 6-cycle pulses respectively. The figures thus obtained were examined to determine the significance of differences between the four channels. No significant difference was found between direct-to-phones- and dead-room-conditions, or between the studio and reverberation room; but there was a highly significant difference (probability considerably less than 0·01) between the first pair (direct) and the second pair (reverberant). The results obtained are shown in the accompanying table.



Pulse oscillograms (*a*) after transmission through dead room; (*b*) after transmission through reverberation room

The spectrum of a continuous tone is a single line; but a tone pulse of finite length has a spectrum the effective breadth of which widens rapidly as the number of cycles diminishes to unity and less. Thus we find mean values of $|\delta|$ for 3-cycle pulses almost exactly twice as much as for 6-cycle pulses (actual ratios 1·98 : 1 for direct sound, and 2·04 : 1 for reverberant sound).

It is not clear, however, why the reverberant sound should give a stronger pitch sensation than direct sound. The reflexions from the walls of the reverberant room cause the short train of waves to impinge upon the ear several times, but there will be no fixed relation between the phases of these repetitions. The accompanying oscillograms are of the headphone signals from the dead room and reverberation room respectively. The breadth of the spectrum of a succession of randomly phased trains is fundamentally the same as that of a single train, and might be expected to have the same effect on the series of elements constituting the cochlea. It is highly probable that the uncertainty of a subjective judgment of frequency in a short pulse is greater than the theoretical limit deduced from the ear mechanism, and the difference of behaviour established by these experiments therefore appears to imply that the brain is capable of making a more accurate assessment of the cochlear response if afforded several opportunities in quick succession.

Increase of reverberation-time beyond a certain point is usually accompanied by prominent eigentones which are shock-excited by the pulse, and thus the room acoustics do not produce further improvement.

This phenomenon, therefore, has implications which do not seem to be fully met by present theories of hearing, and the object of this communication is to bring it to the notice of workers in the field of hearing, to whom it may be new.

We acknowledge the assistance given by our colleagues in the B.B.C. Research Department in carrying out these experiments.

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Nov. 23.

Anomalous Refraction Effect in Electron Diffraction

THE multiple fine structure of the electron diffraction Debye–Scherrer rings due to the refraction of electron waves at surfaces of crystal particles having a well-defined crystal shape, such as magnesium oxide and cadmium oxide smokes of cubic habit, were first noted by Sturkey and Frevel[1] and Hillier and Baker[2], and studied in more detail by Cowley and Rees[3] and one of us[4]. But the crystallites in the powder samples used in these investigations have arbitrary orientations with respect to the electron beam, so that it is difficult to speak of the refraction effect with a definite geometrical relation between crystal and beam.

Fibre diagram of magnesium oxide. Camera length, 50 cm.

One of us (G. H.) has recently succeeded in obtaining samples of magnesium oxide and cadmium oxide smokes having a fibrous orientation with the [001] axis perpendicular to the underlying surface, by depositing them upon flat surfaces of silicon carbide single crystals in air. It was found that most of the spots in the fibre diagram obtained with these samples, using the reflexion method, are doublets in which the two spots are separated in the horizontal direction, apparently corresponding to the refraction effect at surfaces of the cubic crystallites (see photograph). By virtue of the preferred orientation in our samples, the geometrical relation is well defined for each reflexion, except for (00n). For example, (*hhl*) reflexions come only from crystallites with [110] axes perpendicular, and [$\bar{1}$10] axes nearly parallel, to the electron beam.

It may first be thought that this horizontal separation is useful for a more precise determination of the refractive index of the crystal for electrons than in previous investigations. But the case is not so simple. As is shown in the accompanying table, the refractive indices obtained from our pattern depend considerably on the indices of the reflexions, and sometimes assume extraordinarily large values compared with those obtained previously or from theoretical estimates[5].

This anomalous refraction effect can be explained by applying Bethe's dynamical theory of electron diffraction[6]. For the present problem, however, we must take account of the special geometrical relation in which the electron beam and the reflecting crystallites stand to each other; the electrons reflected by, for example, the (*hhl*) plane are reflected simultaneously by the ($\bar{h}\bar{h}l$) plane on account of the symmetry, so that we have now the three *strong* rays within the crystal, one primary and two diffracted. Such a case can be treated theoretically by applying Bethe's theory for *symmetrical* reflexions. The unit increment δ of the refractive index n ($n = 1 + \delta$), which is effective for the separation of the double spots, is then given by

$$\delta = \frac{\hbar^2}{16\pi^2 me} \cdot \frac{2v_0 - V_{11} - V_{22} - V_{23}}{2E},$$

where

$$V_{11} = \Sigma'_g \frac{v_{-g}\, v_g}{\varkappa_0^2 - k_g^2}, \quad V_{22} = \Sigma'_g \frac{v_{g_1 - g}\, v_{g - g_1}}{\varkappa_0^2 - k_g^2}$$

$$V_{23} = \Sigma'_g \frac{v_{g_1 - g}\, v_{g - g_2}}{\varkappa_0^2 - k_g^2} - v_{g_1 - g_2}.$$

The notation follows Bethe's: E is energy of electrons; k_g is magnitude of wave vectors of wave in crystal; $\frac{\hbar^2}{16\pi^2 me} v_g$ is the Fourier coefficient of periodic potential field in the crystal; $\varkappa_0^2 = \frac{8\pi^2 me}{\hbar^2} E + v_0$; v_0 is the zero term of v_g; $g_1 g_2$ are indices of reflexions of the two diffracted rays.

V_{11} and V_{22} are quantities depending upon the direction of the electron beam with respect to the crystal, being in general so small that they may be neglected. But if the beam is nearly parallel to important zone axes, as in the present problem, many terms in the summations take on considerable values on account of the small magnitudes of the denominators, so that the contribution of V_{11} and V_{22} becomes far from negligible. Similarly, the summation term in V_{23} also becomes appreciable. The values of V_{11}, V_{22} and V_{23} can be estimated by using the structure factor for the crystal. In the fifth and sixth columns of the accompanying table, the theoretical and experimental values of $\delta.2E \equiv \Phi$ (the effective mean inner potential of the crystal), in volts, are compared for the (111), (113) and (226) reflexions of magnesium oxide smoke, and it will be seen that there is reasonable agreement.

Plane index	$\frac{\hbar^2}{8\pi^2 me} \cdot V_{11}$ (volt)	$\frac{\hbar^2}{8\pi^2 me} \cdot V_{22}$ (volt)	$\frac{\hbar^2}{8\pi^2 me} \cdot V_{23}$ (volt)	Φ (volt)		$\frac{\hbar^2}{8\pi^2 me} \cdot V_{12}$ (volt)
				calc.*	obs.	
(111)	0·15	−7·15	−11·7	23·35	23·4	−1·59
(113)	−1·42	11·9	4·5	6·0	10·4	1·73
(226)	1·49	1·72	−1·80	13·35	14·6	−0·15

* $\Phi_{calc.}$ is calculated by assuming the value of the mean inner potential $\Phi_0 \equiv \frac{\hbar^2}{8\pi^2 me} v_0$ to be 14 volts for MgO.

According to the dynamical theory, as pointed out by Sturkey[7], each spot in a doublet should be further split into two by double refraction; but this effect could not be observed in our experiments, probably because of the small values of V_{12} (in Bethe's notation) for the reflexions of MgO included in the table.

The results of further observations and fuller descriptions will be given elsewhere.

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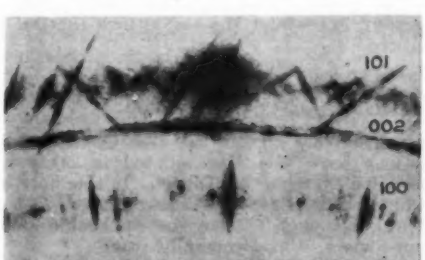
Line-Breadth in Electron Diffraction

ONE of the major factors determining line-breadth in electron diffraction powder patterns has been shown[1-3] to be the refraction of the electron beam resulting from the finite inner potential of the crystals. Striking differences in line-breadth occur in patterns from crystals of regular habit, such as the cubes of magnesium oxide and cadmium oxide smokes and the elongated hexagonal prisms of zinc oxide smoke. Certain reflexions, for example, $h00$ in magnesium and cadmium oxides, and $00l$ in zinc oxide, are sharply defined, and it has been shown by Cowley and Rees[3] that the refraction components lie along these rings and do not contribute to the line-breadths. Moreover, any elongation of reflexions arising from the non-spherical symmetry of the scattering function about the reciprocal lattice points for zinc oxide of this habit will lie along these rings also. Nevertheless, these breadths are still greater than can be accounted for by limitation of crystal dimensions and the finite breadth of the beam.

Patterns of zinc oxide smoke recorded with a high-resolution diffraction camera designed and constructed in this laboratory[4] have shown that variation of lattice parameters, at least in small crystals of this type, makes a considerably larger contribution than hitherto suspected. In the accompanying photograph, a greatly enlarged portion of a zinc oxide pattern is reproduced to demonstrate a spread of the 002 reflexion amounting to 1·1 per cent. At a number of places on this ring, the individual crystals contributing have sufficiently different cell dimensions to produce an apparent doubling of the ring. The fine structure apparent in the two other rings in the photograph, 100 and 101, is ascribed to both refraction and the shape of the scattering function in reciprocal space (determined by the crystal habit); this will be the subject of a forthcoming publication by us. The 200 rings of magnesium and cadmium oxides show a similar spread of the lattice parameter (see ref. 2, Fig. 4).



Portion of an electron diffraction pattern from zinc oxide showing the 100, 002 and 101 rings. The variation in cell dimensions from crystal to crystal is evident in the 002 ring. Enlargement, 12 ×

Possible explanations are: (1) that lattice strains exist as a result of bending of the long zinc oxide spines; (2) that the smaller crystals contributing to the pattern have smaller cell dimensions in accordance with the theory of Lennard-Jones[5]; and (3) that there are slight differences of composition or structure from crystal to crystal resulting from the conditions of preparation. Lattice strains would result in the occurrence of a range of parameters in each crystal, whereas the individual single-crystal reflexions are sharply resolved in the direction of the radius vector (see photograph). It appears more likely that either crystal dimensions or non-stoichiometric composition may account for these variations in cell dimensions from crystal to crystal; the latter is a distinct possibility for such small crystals of these oxides prepared by burning the pure metal in oxygen. For zinc oxide particles of length $\sim 3 \times 10^3$ A. (estimated from electron micrographs), the half-width of the 002 reflexion, calculated from Brill's formula, is 2×10^{-5} radian. The half-width of the whole line measured by microphotometry is $8{\cdot}4 \times 10^{-5}$ radian, and that of the single reflexion, $2{\cdot}8 \times 10^{-5}$ radian.

It would appear that the breadths of electron diffraction rings, obtained under high-resolution conditions, may be accounted for completely by contributions from (1) broadening governed by the size and shape of the crystals, (2) refraction, and (3) spread of lattice parameters.

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Electrical Properties of Gold–Chromium Alloys

IT is known from earlier researches[1,2] that the gold–chromium alloys are characterized by a decrease of electrical resistivity when deformed plastically by cold-working. In an investigation on alloys with fairly high concentration of chromium, I have found, in addition to the effects already known, certain new resistance properties.

Fig. 1 gives the results of measurements of the change of resistance with time when ageing cold-worked specimens (degree of reduction of area 0·987) at + 20°, 100° or 200° C., the alloy containing 21·6 atomic per cent chromium and 0·2 atomic per cent iron (as impurity). R_0 denotes the resistance value obtained immediately after cold-working the specimen, all measurements being made at room temperature. After 650 hr. at 20° C., R/R_0 had reached the value 1·058 (not plotted in the graph). The final resistance of a given sample when completely re-

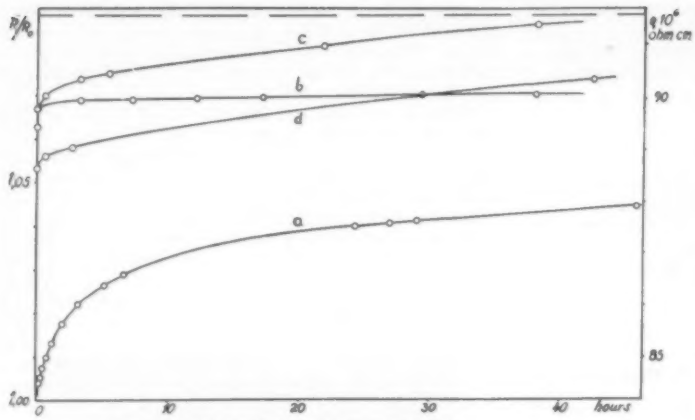

Fig. 1 (*a*) Cold-worked specimen aged at 20° C.
(*b*) ,, ,, ,, ,, 100° C.
(*c*) ,, ,, ,, ,, 200° C.
(*d*) Specimen quenched from 490° C., aged at 200° C.

covered at 200° C. is indicated in the figure by a dashed line. In view of the high melting point of the alloy (about 1,120° C.), it is remarkable that the recovery process is so very pronounced at these low temperatures. The alloy shows no supersaturation phenomena.

Fig. 2 shows the resistance-temperature curve for the above-mentioned alloy. The curve can be reproduced for slow temperature changes in either direction, but if the sample is cooled rapidly from a high temperature (say, 400° C.) to room temperature and the resistance is measured, a lower value is observed than that of the curve for 20° C. This is seen from the resistances measured after quenching from 300° and 490° C., which are indicated in the graph. On ageing the quenched sample afterwards at a fixed temperature, the resistance increases in the manner shown in Fig. 1, ultimately reaching a constant value. Thus the effect of combined heat-treatment and quenching of the sample is similar to that of cold-working as regards the electrical resistivity of the specimen. For annealing temperatures of 200° C. or lower the effect of quenching on the resistance is very small or non-existent.

From the low value of the temperature sufficient for recovery (Fig. 1), it appears that the observed resistance effects are not caused by a diffusion process (migration of the atoms). To account for the effect of cold-working on the resistivity, I have assumed

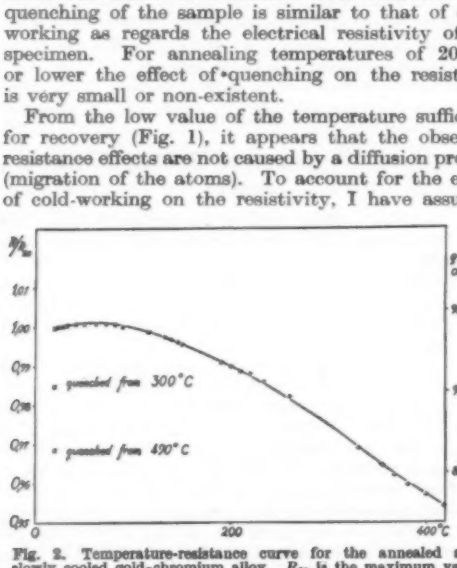

Fig. 2. Temperature-resistance curve for the annealed and slowly cooled gold-chromium alloy. R_{20} is the maximum value of R obtained at 20° C.

a change of the electron configuration of the chromium atoms to be responsible for the abnormal change in resistivity (decrease of resistivity[2]). This interpretation may also be valid for the effects appearing in the heat-treatment and quenching process. It is supposed that atoms which are much displaced from their normal sites in the lattice are of importance for the decrease in resistivity, owing to a temporary change in the electron configuration of these atoms, the distance between neighbouring atoms in the lattice being critical for the stability of a given electron configuration of an atom.

These results give valuable information as to the best method of artificially ageing resistance materials for which the resistance is required to be constant with time. It is found that annealing a cold-worked sample of the gold–chromium alloy gives a fairly constant resistance after 10 hr. at 100° C. (Fig. 1); but the value then reached is by no means the final value (corresponding to equilibrium). In fact, specimens annealed in this manner have shown an increase in resistance also when aged at room temperature, when observations are extended over a long time. On the other hand, annealing the cold-worked sample at 200° C. resulted in a constant resistance after about 60 hr., and the value obtained corresponds apparently to the true equilibrium of the alloy at this temperature. A specimen annealed at 490° C. and quenched from this temperature needs, as curves *c* and *d* in Fig. 1 show, a longer time of annealing at 200° C. than the cold-worked specimen to reach the final stable resistance value.

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Mayer Analysis of Metals

In a recent communication under this title, Finniston, Jones and Madsen[1] utilize the two basic equations

$$L = ad^n \qquad (1)$$

and

$$aD^{n-2} = \text{constant}, \qquad (2)$$

due respectively to Mayer[2] and O'Neill[3]. These equations have also been quoted in other recent papers, for example, by Tabor[4]. It therefore seems desirable to make available some results which show that (2), although it may be applicable in some circumstances, is not generally true.

It is found that when a steel ball is pressed into a lead surface, (1) is obeyed for an index $n = 2$, but that the value of a is not independent of D as would be required by (2) on substituting this value of n.

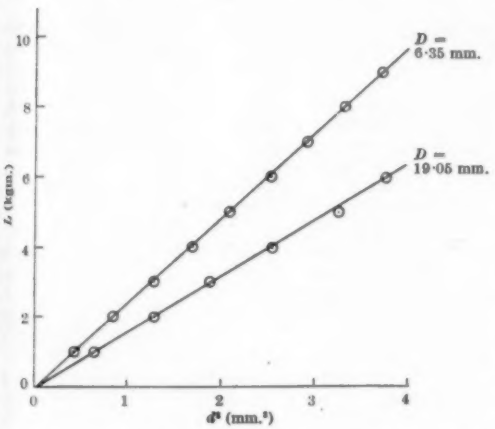
In contrast, however, with this failure of equation (2), it is found that (1) is of more general application. The equation

$$L = ad^3$$

applies with the same value of a both when a steel ball is pressed into a plane lead surface and when a lead hemisphere of the same diameter is pressed on to a plane glass surface. It is found, further, that when a steel ball of diameter D_1 is pressed into a convex lead surface forming part of a sphere of diameter D_2, the same equation holds with a value of a corresponding to that for a ball of diameter D pressed into a plane surface, where

$$\frac{1}{D} = \frac{1}{D_1} + \frac{1}{D_2}.$$

The quantity a is therefore a function of the change in curvature of the deformed surface.



The linearity of the relationship between L and d^3, and the difference in the slope of the lines for two values of D, is shown in the accompanying figure. The precise form of the variation of a with D is found to be dependent on a number of factors such as the purity of the lead (which affects its capacity for work-hardening), and the time during which the load is applied; but it is unaffected by the presence of a lubricant between the surfaces. None of these factors has been found to affect the value of n.

The results obtained using lead hemispheres pressed on to glass plates were remarkable in that the relations discussed above persisted even at loads so high that the diameter of the circle of contact exceeded the diameter of the original hemisphere. Similar results were obtained using indium in place of lead.

There does not appear to be any generally known theory which will account for all the facts described.

We wish to thank the directors of Ferodo, Ltd., for permission to publish this work.

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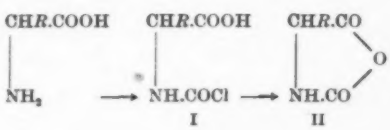
Anhydro-N-Carboxy-DL-β-Phenylalanine

A. L. Levy[1] has described the preparation of anhydro-N-carboxy-DL-β-phenylalanine (II, R=CH_2Ph) by the action of phosgene on DL-β-phenylalanine. Prior to this, Fuchs[2] described the preparation of anhydro-N-carboxy-N-phenyl- and N-*p*-tolyl-glycine by phosgenation of the parent acids in aqueous solution. Isatoic anhydride[3], the analogous compound from anthranilic acid, has been similarly prepared. A modified method based on this reaction of Fuchs has been used recently by several workers in these laboratories. The process, which is fairly generally applicable and has been protected by a patent application[4], consists of suspending the powdered α-amino-acid in a dry inert solvent, for example, dioxan or tetrahydrofuran, at 30°–40° and passing in gaseous phosgene with stirring until the acid is dissolved. Removal of solvent and excess phosgene by heating *in vacuo* at 40° then affords the anhydro-N-carboxy derivative (II), the intermediate N-substituted carbamyl chloride (I) being decomposed with the loss of hydrochloric acid during the treatment:



By this route it has been possible to prepare the anhydro-N-carboxy derivatives of glycine, DL-β-phenylalanine, α-amino*iso*butyric acid and L-leucine. During the preparation of the glycine derivative, the presence of N-carboxymethylcarbamyl chloride (I, R = H) was shown by addition of aniline to the intermediate product, giving N-phenylhydantoic acid.

This work, which has been carried out in connexion with research on synthetic polypeptides[5], will be described in detail by D. Coleman and A. C. Farthing in forthcoming publications.

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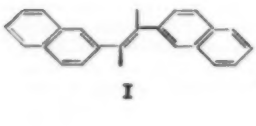
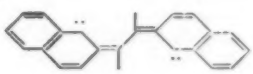
Addition of Osmium Tetroxide to Dinaphthylethylenes

It has been claimed by Pullman[1] that the extent of conjugation of a given substituent with an aromatic ring system is determined by the electron density (index of free valence) at the position of substitution. Using the customary resonance terminology, this conclusion may be illustrated by the fact that for 1-substituted naphthalenes there are seven possible structures in which the substituent is linked to the ring by a double bond, but that for 2-substituted

naphthalenes there are only six such structures. If X is a substituent, the C—X bond in 1-substituted naphthalenes should therefore have greater double-bond character than the corresponding bond in 2-substituted naphthalenes, and examination of the dipole moments of the halogenated naphthalenes confirms that this is the case[2]. Furthermore, examination of the ultra-violet absorption spectra of suitable substituted compounds shows that there is a correlation between the magnitude of the bathochromic shift, the extent of conjugation, and the index of free valency at the position of substitution[3]. The experimental evidence supporting Pullman's generalization is not, however, extensive, and the present work was undertaken to provide further information of interest.



I

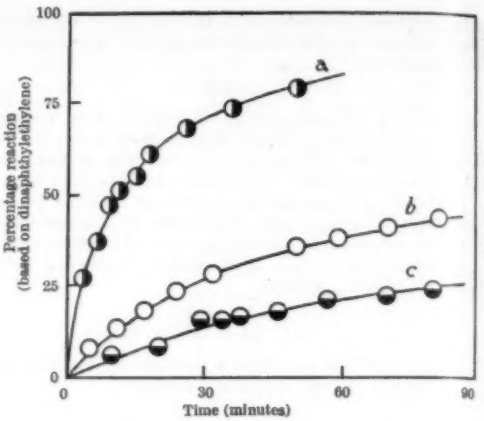


II

There are six possible dinaphthylethylenes having one α- or β-naphthyl radical attached to each of the ethylenic carbon atoms, namely, *trans*-αα-, *trans*-αβ-, and *trans*-ββ-dinaphthylethylene, and the three corresponding *cis*- isomers. In each case the conjugation of the ethylenic bond with the aromatic rings may be represented by a series of ionic structures of type II, in which the classical double bond is written as a single bond. The extent of conjugation may be considered in terms of the importance of the contribution which structures of type II make to the resonance hybrids, and the greater the conjugation the smaller the double-bond character of the classical double bond. Other factors being equal, the rate of addition of osmium tetroxide to double bonds is governed by the double-bond character, and a study of the rate of reaction of this reagent with the six dinaphthylethylenes has therefore been carried out by the method previously reported[4]. The preparation of the dinaphthylethylenes has already been described[5], and I am indebted to Prof. G. A. R. Kon for gifts of most of the specimens used in the present work.

In both the *cis*- and the *trans*- series, ββ-dinaphthylethylene was found to react most rapidly with osmium tetroxide, αα-dinaphthylethylene least rapidly, and αβ-dinaphthylethylene was found to be of intermediate reactivity. As the α-position of naphthalene has a greater index of free valence than the β-position, the ethylenic double bond is conjugated with an α-naphthyl radical to a greater extent than with a β-naphthyl radical, and the classical double bond in αα-dinaphthylethylene has less double-bond character than in ββ-dinaphthylethylene. This is reflected in the rates of reaction, and the results of the present work appear to support Pullman's generalization.

In the *trans*- series, the reaction was carried out at a hydrocarbon concentration of 0·001 M and osmium tetroxide, 0·00156 M. The reaction with *trans*-ββ-dinaphthylethylene was 50 per cent complete in 2 min., with *trans*-αβ-dinaphthylethylene in 3 min., and with the αα-derivative in 5 min. The *cis*-compounds all reacted more slowly than the *trans*-isomers, and for this reason the reaction was measured

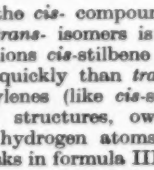


Curves showing the rate of reaction of *cis*-ββ-dinaphthylethylene (*a*), *cis*-αβ-dinaphthylethylene (*b*), and *cis*-αα-dinaphthylethylene (*c*) with osmium tetroxide

at a hydrocarbon concentration of 0·004 M, and osmium tetroxide, 0·00624 M. In the accompanying figure the curves indicate a marked difference in the reactivity of the three compounds.

That the reaction is not accompanied by rearrangement has been shown by examination of the reaction products from the *cis*- and *trans*-ββ-dinaphthylethylenes. Mild hydrolysis of the brown crystalline complex of the *cis*- isomer with osmium tetroxide and pyridine gave the sparingly soluble hydro-ββ-naphthoin as colourless plates, melting point 255–257° (found: C, 84·2; H, 5·8; calc. for $C_{28}H_{18}O_2$, C, 84·1; H, 5·8 per cent). This product is evidently identical with the hydro-ββ-naphthoin (m.p. 253°) obtained by Fulton and Robinson[6] by another method. Hydrolysis of the osmium tetroxide-pyridine complex with *trans*-ββ-dinaphthylethylene gave *iso*hydro-ββ-naphthoin as colourless plates (from alcohol), melting point 218–219° (found: C, 83·9; H, 5·8; $C_{28}H_{18}O_2$ requires C, 84·1; H, 5·8 per cent).

The fact that the *cis*- compounds all react more slowly than the *trans*- isomers is surprising, for in most of its reactions *cis*-stilbene resembles styrene and reacts more quickly than *trans*-stilbene[7]. The *cis*-dinaphthylethylenes (like *cis*-stilbene[8]) must all have non-planar structures, owing to the overcrowding of the hydrogen atoms at the positions shown with asterisks in formula III. This non-planar configuration prevents extended conjugation of the



III

ethylenic bond with both naphthyl radicals, and in the *cis*- isomers the ethylenic double bond must therefore have greater double-bond character than is the case with the planar *trans*- compounds. On the other hand, the projection of one naphthyl radical above the plane of the double bond[9] may well provide considerable steric hindrance to the approach of the

large osmium tetroxide–pyridine molecule, and lead to slower addition.

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Serum Potassium by Internal Standard Flame Photometry

Flame photometric analysis[1] of cations in biological fluids and tissues is, because of its simplicity, rapidity and greater accuracy, replacing laborious chemical procedures. The vaporization of alkali metal solutions in constant amount per minute into a controlled low-temperature air–acetylene flame produces simple emission spectra, the light intensities of which, measured photo-electrically after slit isolation of the most sensitive line spectrum for the particular element (potassium red flame at 7665 A.), are practically proportional to their concentrations for low concentrations[2].

Absolute light-intensity measurements are subject to errors, due to variable viscosity, surface tension and composition of samples affecting the rate of atomization and the character of the flame[1,2]. However, the addition of lithium to all solutions analysed provides a means of internal standard compensation whereby light-intensity ratios are determined. Variations are thus considerably reduced, and recoveries with an average error of ± 2 per cent are obtained for sodium and potassium, using a Perkin–Elmer 52A flame photometer[3].

A notable exception occurs in the estimation of serum potassium, where sodium is present in concentration (± 145 m.eq./litre) some twenty-five times that of potassium (± 5 m.eq./litre). Due to the phenomenon of mutual excitation, more luminous energy per m.eq. potassium is produced in the presence of a large excess of sodium than from potassium in pure solution (sodium *per se* produces no spectral emission at the potassium wave-length). This enhanced excitation, not completely compensated for by the added lithium, is found to be fairly uniform over a range of 20–50 Na : 1 K for potassium calibration solutions covering a 1 : 5 to 1 : 20 serum dilution :

Effect of sodium added to potassium solutions (potassium 0–2 m.eq./litre at 0·25 intervals)

Ratio sodium : potassium	% Light emission at potassium wave-length
0 : 1	100
5 : 1	100–102
10 : 1	102–105
20 : 1	106–109
30 : 1	107–110
40 : 1	105–108
50 : 1	108–110
100 : 1	100–102
200 : 1	96–98

Hence reference to a potassium calibration curve to which sodium is added, depending on the serum dilution for estimation, in the equivalent of 145 m.eq./litre, will cover a serum-sodium range from 100 to 180 m.eq./litre and so provide adequate compensation for pathological variations of serum sodium.

Recovery from standard solutions (combinations of 4, 5, 6 m.eq. potassium per litre with 100, 125, 150, 175 m.eq. sodium per litre) and of potassium added to serum samples yields average recovery errors of ± 2·3 per cent for flame photometric analysis and ± 4·2 per cent by chemical estimation. Serum potassium estimations by flame photometry, using dry ashing or deproteinizing techniques, give slightly lower results than the chemical method of Cumings[4].

Recovery and serum values are 5–10 per cent too high by flame photometric analysis using a pure potassium calibration curve.

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Antibiotics in the Treatment of Amœbiasis

Recent work by McVay, Laird and Sprunt[1] has shown that aureomycin may be of value in the treatment of amœbiasis. Because of the small number of cases they reported on, and the comparatively short period of parasitological examination after treatment, it is impossible, as yet, to judge the true value of this antibiotic as an anti-amœbic drug.

In an experimental amœbic infection of rats[2], aureomycin produced a significant therapeutic effect at doses of 5–10 mgm./kgm. Penicillin and streptomycin produced a similar effect at doses of 6·25 mgm./kgm. and 2 mgm./kgm., respectively, whereas chloromycetin had no effect unless the comparatively high dose of 100 mgm./kgm. was used. Of these three latter antibiotics, only penicillin has been used in human amœbiasis, so far as can be ascertained from published literature. It was first used for treating refractory cases of acute amœbic dysentery by Hargreaves in 1945[3]. Hargreaves's work, and that of others afterwards, showed the effect of penicillin to be due primarily to an action on secondary bacterial infection. Although a significant clinical improvement resulted from treatment with penicillin, *Entamœba histolytica* persisted, and could be eradicated only by formal treatment with amœbicidal drugs.

McVay *et al.* make the important claim that treatment with aureomycin results not only in clinical improvement, but also in a disappearance of parasites. This effect suggests an important point of difference from that of penicillin; namely, that aureomycin has some direct lethal action on the amœbæ. Unfortunately, it is difficult to investigate the direct action of drugs on *Entamœba histolytica* because of our inability to cultivate the parasite free from bacteria. At concentrations down to 1 in 90,000, aureomycin prevents growth of a strain of *E. histolytica* in simple liquid medium, in the presence of a single species of bacterium (*B. coli*). Using another

strain of amœbæ associated with a complex bacterial flora, the minimal inhibitory concentration is 1 in 30,000. Chloromycetin behaves in precisely the same manner against the two strains; but penicillin and streptomycin are considerably less active against the strain carrying the complex bacterial flora than they are against that carrying only *B. coli*. Minimal effective concentrations of both penicillin and streptomycin are more than 1 in 1,000 against the former strain, and 1 in 270,000 against the latter.

The successful use of penicillin and aureomycin in the treatment of amœbiasis raises the question whether or not organisms exist which may, under natural conditions, produce substances inhibitory to *E. histolytica*. Stewart, Jones and Rogers[4] showed that an enterococcus can under certain conditions inhibit the growth of this amœba by the production of lactic acid. Singh[5] showed that pigments produced by certain bacteria of the genus *Chromobacterium* are toxic to soil Protozoa. It is possible, therefore, that the intestinal flora or fauna may provide a source of some specific anti-amœbic agent.

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Influence of Vertebrate Gonadotropic Hormones upon the Reproductive Cycle of Certain Protozoa in Frogs

Zeller[1] and, later on, Neresheimer[2] and Metcalf[3] made observations of the reproductive cycle in Opalinids; Bojeva-Pietrushevskaja[4] has described sexual reproduction in *Nyctotherus cordiformis*.

These parasitic Protozoa live during the whole year in the rectum of frogs, dividing occasionally by longitudinal and transverse fission. In spring, parallel to the breeding season in their host, a change from asexual multiplication to sexual reproduction in the Protozoa takes place. They begin to divide with greater frequency, forming finally minute forms with but a single nucleus. These individuals then encyst, and passing out with the fæces of the host into the water, fall to the bottom and remain there until the frog eggs have developed into tadpoles. The cysts are ingested by these larvæ and hatch out; the young Infusoria divide several times, forming ultimately minute forms, gametes (in Opalinids) or preconjugants (in *Nyctotherus cordiformis*). According to Neresheimer, the following copulation is merogamic in type, the isogametes resembling small trypanosomes. Metcalf describes a heterogamic fusion with macrogametes closely resembling the ordinary form, except that they are usually uninucleate, and microgametes with a slender tapering tail.

The most striking and easily observed moment in this process is the appearance of encysted forms marking the change from asexual to sexual reproduction in the Protozoa. I have not been able to find any account in the literature of the factors causing this change.

Experimenting on male frogs used for pregnancy diagnosis[5], interesting pictures of protozoan life were observed after an injection of pregnancy urine in a droplet of cloacal urine. A great variety of forms, including mature spermatozoa, immature elements of seminiferous epithelium, actively moving Opalinids, *Nyctotherus cordiformis*, *Balantidium entozoon*, sometimes *Rhabdias bufonis*, encysted immobile forms and various minute individuals swimming about made appraisal and classification difficult. An interesting observation was that of encysted forms, 20–50 μ in diameter, oval in shape, with continuous movement between the distinct cyst wall and the ectosarc of the enclosed individual, arising from the movement of its cilia. A few refractive globules were observed towards one of the poles, moving constantly, probably through the movement of the cilia. The encysted organism also showed activity, becoming narrow for a while, or forming a tongue-like projection on one side. It became very active after some time, its revolutions increasing, until finally the cyst wall broke, releasing an infusorian form. The residue of the cyst wall and some granular debris were left behind.

The appearance of cysts of this character in frogs infected with *Nyctotherus cordiformis* only, and the hatching of an infusorian form which resembled that of this species, suggests that it was an encysted form of this protozoan. Cysts of different appearance, size and shape were encountered, according to the parasitic fauna of the host.

Few cysts of *Rhabdias bufonis* were seen. They usually passed out with particles of green fæces which obstructed the view. The cyst wall was thin and delicate and the animal wound itself within like a snake, showing slow rotatory movements. Its revolutions became more active before hatching, which usually took place very early, soon after the encystment (1–3 hr.). After that time only freely moving forms, and the remains of the cyst wall, were to be seen.

A multitude of minute individuals moving freely about was often to be seen, most of them looking like small flagellates, showing some similarity to frog spermatozoa, but smaller, more round in shape and more active; a few individuals of a rod-like shape, moving slowly, were also encountered. It is difficult to say whether these were microgametes or mature forms of some other species.

In the urine of a normal frog, or one which had received injections of normal female or male urine, only a few or single Protozoa could be found occasionally; they were never so active or numerous as after an injection of pregnancy urine. Except during the breeding period of the frog, encysted forms of Protozoa were never seen without an injection of pregnancy urine. Such injections caused regularly the changes described earlier, with the appearance of encysted forms, wherever there were protozoan parasites in the rectum of the frog. The encystment of the Protozoa can be observed only during February to May. After the frogs' breeding period, or after a previous injection of pregnancy urine, the Protozoa, which have already gone through their sexual reproductive cycle, are resistant to the effect for a period of some eight months. It appears as if a certain number of generations of simple fission is necessary before sexual maturity is attained.

It seems probable that the observed change from asexual life to sexual reproduction in these Protozoa, marked by the appearance of characteristic encysted

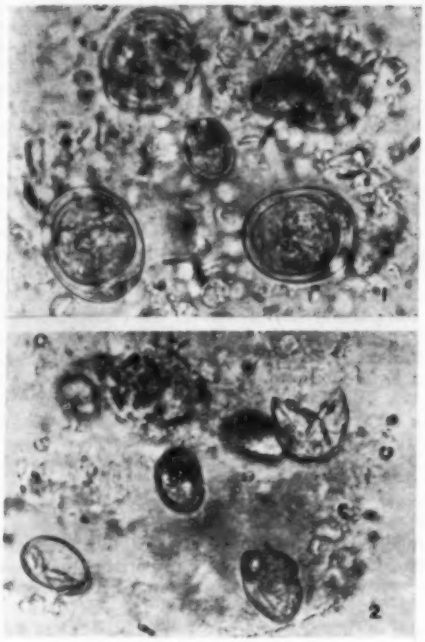

Fig. 1. Encysted forms of Protozoa, single spermatozoa and spermatocysts. Hanging droplet of male frog's cloacal urine *in vitro*

Fig. 2. The same field 36 hr. later. The cyst walls after hatching of infusorians

From the Laboratory of Scientific Cinephotography and Photography, Institute of Maritime and Tropical Medicine, Gdańsk

forms, may be initiated by human chorionic gonadotropin present in great quantities in pregnancy urine. The factor causing a similar change during the breeding season of the frog is probably frog gonadotropin, released from the anterior pituitary during copulation.

The observed influence upon the reproduction of Protozoa is so characteristic for the gonadotropic effect in higher animals that one might well suppose a similar influence upon the sexual activity of the Infusoria.

Some further unknown factors, active in the organism of the host only, must play an important part in this change. Hitherto we have not succeeded in producing such a change in reproduction in isolated cultures of these Protozoa by the application of human pregnancy urine alone, although the addition of thyroxin caused changes in *Nyctotherus cordiformis* very similar to those observed in encysted forms: the adoption of a round oval shape, and the loss of mobility with preservation of a delicate movement of the cilia. Unfortunately, neither encystment nor sexual reproduction could be initiated artificially in these conditions. It seems to be a composite effect of a whole complex of factors which, only when acting together, or one after another, as, for example, within the host organism, causes the change from the vegetative existence to sexual reproduction in the Protozoa.

It is possible that different elements of this complex, or further links in this chain, acting upon the infusorian form, are not so much of a special, hormonal character, but rather of a more simple biochemical and oligodynamic nature. Hormonal activity is the youngest and phylogenetically the most differentiated correlative sphere in living organisms. A certain degree of regression in order to influence less differentiated organisms such as Protozoa is to be expected.

Whether the influence is direct or indirect, it is the gonadotropic hormones which start the whole process of the activation of sexual life in these Protozoa. Thus these observations are an interesting example of hormonal symbiosis—a biological action of vertebrate hormones upon the reproductivity of living invertebrates. The observed relationship is most probably not an isolated phenomenon. In the light of new concepts and observations relating to sexual reproduction even in bacteria[6] and viruses[7,8], it might be interesting to look for such hormonal influences not only upon Protozoa, but also on bacteria and virus bodies.

We have begun work on these lines. In addition, investigations on the isolation and cultivation of these Protozoa, work for the detection of the whole complex of factors causing their sexual activation, and the possible use of the encystment phenomenon for a pregnancy test, have been initiated.

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Conversion of Nitrites into Oximes in Silkworms and its Relation to the Experimental Production of Virus Disease

Five years ago we found[1] that hydroxylamine causes the formation of virus protein in the body of the silkworm without virus infection. As it has been established, particularly by Virtanen[2], that hydroxylamine and oxaloacetic acid oxime appear as intermediate products of nitrogen fixation by bacteria, I assumed that these compounds must be widely distributed in animals and plants and often act as general agents which provoke the outbreak of virus diseases. In recent experiments we have shown[3] that various animal and plant tissues contain oximes and the oxime-content changes with the growth. In this communication I propose to describe briefly the results of experiments in which silkworms were fed with nitrites.

I gave silkworms mulberry leaves which were moistened with a potassium nitrite solution. The feeding of nitrite was begun on the first day of the fourth instar. At first the concentration of nitrite solution was 3 per cent, but after five days it was increased to 5 per cent. The worms were fed with nitrite once a day, and at the other meal-times normal mulberry leaves were given. It was observed that 46 per cent of such treated silkworms died of jaundice virus disease in the early stage of the fifth instar. In the group of untreated worms no diseased individual appeared. I estimated the oxime content of the

bodies of silkworms fed with potassium nitrite and yet remaining healthy. It was found that such a worm contained 0·67 mgm. of combined hydroxylamine per 1 kgm. fresh body-weight. But the untreated, normal worm contained about one-seventh of the oxime present in the treated worm.

In the second experiment, the silkworms were fed with sodium nitrite instead of potassium nitrite. The concentration of sodium nitrite solution, however, was 1·5–2·5 per cent. The procedure was the same as in the previous experiment. In this experiment only 10 per cent of treated worms were attacked by the virus disease. This result is perhaps to be attributed to the lower concentration of nitrite used. The oxime content in the body of the worm was much increased by feeding with sodium nitrite.

In supplementary experiments I found that the feeding of nitrates and ammonium salts causes an increase of oxime content in the silkworm. In all these experiments great care was taken to avoid contamination by viruses or micro-organisms. So far as I know, the results of the present study offer the first case showing that, in an animal body, nitrogen in the form of inorganic salts in foods can be converted into organic nitrogen. Hence these animals can utilize inorganic nitrogenous compounds as nutritive substances.

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South African Fossil Anthropoids

A REPORT has just been published[1] of the Fourth Summer Seminar in Physical Anthropology held in New York at the end of August 1949 under the auspices of the Viking Fund. The evolutionary significance of the South African fossil anthropoids (Australopithecinæ) was discussed at several of the meetings, and at one I gave a short account of some comparisons, made by the appropriate statistical methods, and in collaboration with my colleague, Mr. E. H. Ashton, between the dimensions of the teeth of the fossils and those of existing apes. The conclusions to which they point disagree with the claims of a number of workers[2] that in their size and shape the fossil teeth are in general more hominid than anthropoid. Comparisons made dimension by dimension and index by index have revealed few significant differences from all three types of extant great ape. Thus, of seventy-five dental characters of *Plesianthropus*, only four differed from the gorilla and none from the orang; and of twenty-six of *Australopithecus prometheus* none differed from either the gorilla or orang-outang.

The account of my remarks in the report of the meetings is associated with the observation that unit comparisons of the kind referred to may be misleading, and that comparisons should be made tooth by tooth —rather than dimension by dimension or index by index—not only with apes but also with man. Tooth by tooth comparisons have been completed, and they show that almost every one of the fossil teeth can be matched in both dimensions and shape by corresponding teeth of the extant great apes. In some cases, moreover, all or many of the teeth of the fossils correspond with those of a single type of modern ape. Thus, of eighteen *Plesianthropus* teeth the dimensions and indices of which have been published, none differs significantly from the orang, and only two from the gorilla. The dimensions of ten teeth of *Australopithecus prometheus* also do not differ from either of these species, while of thirteen teeth of *Paranthropus robustus* the dimensions and indices of which have been studied, all except one do not differ from the orang, and all except three from the gorilla.

The dimensions of the fossil teeth have also been compared with those of the Australian aboriginal, a large-toothed, and with those of the Ancient Egyptian, a medium- to small-toothed, 'race' of *Homo sapiens*. This comparison shows that in their dimensions the teeth of the African fossils resemble those of the two human types far less than they do those of existing apes. A further comparison has revealed the fact that the shape and size of a sample of orang and gorilla teeth taken at random, and constituted so as to correspond with the available fossil teeth of *Plesianthropus* and *Paranthropus*, resemble those of man as closely as, if not more so than, do those of the South African fossil apes.

Full details of the comparisons between the fossil anthropoids and existing apes will shortly be published[3]. The results of the comparisons made with seven types of man will be submitted for publication at a later date.

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Sex and Inheritance in the Serpulid *Pomatoceros triqueter* L.

DURING an investigation of the colours in *Pomatoceros triqueter* L., we have found that this species is a protandrous hermaphrodite. The duration of the male phase of the sexual cycle is subject to individual variation. Some individuals pass through the male phase in less than one month, and then quickly change into the female phase. We have seen many of these animals spawn eggs one week after their last discharge of sperms. Other individuals remain males for months; but—so far as we have been able to see until now—they, too, finally change into females. We have never seen females change into males.

In numerous individuals the terminal plate of the operculum is provided with three divergent chitinous prongs of approximately equal length. Others lack prongs, their opercula having a smooth terminal plate. Breeding experiments have shown that all animals, when young, have opercula without prongs, and they remain so during life. If, however, the operculum is torn off, and a new one is regenerated, it will have prongs on the terminal plate. Consequently all individuals with prongs on their opercula most probably have regenerated opercula.

In the Oslo Fjord the tentacular crowns of *Pomatoceros triqueter* are brown, blue or orange. A quantitative investigation in 1948 based on samples collected once a month during the whole year gave a total of 2,848 individuals, of which 2,628 had brown, 218 blue and 2 orange tentacular crowns.

The colour of the tentacles depends on variation in the concentration of three pigments, blue, red and yellow, and of minute white granules, all individuals possessing all four kinds. In the blue tentacular crowns the blue pigment dominates, with little or none of the yellow; in the brown there is less blue, but more yellow and red pigment; and in the orange the yellow and red pigment dominate, while only traces of the blue are present. Whereas the yellow pigment dissolves at once in alcohol, the blue and red pigment as well as the white granules have remained unchanged even after three years preservation in absolute alcohol.

Crosses within the brown type always give individuals with brown tentacles. We have made twenty-five crosses of brown × brown, giving 8,658 animals, each of which has a brown tentacular crown.

Eleven crosses have been made within the blue type. Each cross gave individuals with blue and brown tentacular crowns in the ratio 3 : 1. The total number of F_1-individuals in blue × blue crosses was 3,837, of which 2,911 had blue and 962 had brown tentacular crowns. From one of these eleven broods two crosses of F_1-individuals with blue tentacular crown were carried out. One cross gave 60, the other 73 F_2-individuals, all with blue tentacles.

Ten crosses have been carried out between individuals with blue and individuals with brown tentacular crowns. Each cross blue × brown gave individuals with blue and brown tentacular crowns, in the ratio 1 : 1, the total numbers being 739 with brown and 755 with blue tentacular crowns.

Further investigations are in progress.

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Somatic Chromosomes of Conjugales

THE following properties of the chromosomes of *Spirogyra* have been demonstrated to the Genetical Society in recent years and an account of them will shortly be published.

(1) *The centromeres.* The British species of *Spirogyra* include those the chromosomes of which have diffuse centromeres or alternatively are polycentric, as well as those with subterminal and median localized centromeres. The parallel separation of the chromatids of *Spirogyra crassa* to the poles of the spindle was first observed by Geitler[1] in 1930.

(2) *The nucleolar-organising chromosomes.* The Conjugales so far as investigated (*Spirogyra, Zygnema, Mougeotia, Sirogonium, Closterium, Cosmarium* spp.) have nucleolar-organising chromosomes the nucleolar organising regions of which are visible inside the nucleolus at resting stage.

The British species of *Spirogyra* include those: (*a*) in which part or the whole of the chromosome concerned is a specialized nucleolar-organising region; (*b*) those in which the nucleolar-organising chromosomes number at least 2, also 3, 4, per nucleus. In some it appears possible that all the chromosomes are nucleolar-organising.

(3) *The 'nucleolar substance' of metaphase.* In *Spirogyra*, at metaphase, anaphase and early telophase, the chromosomes are surrounded by a densely staining substance, in many species forming a thick blanket over the whole metaphase plate, in others (*crassa, triformis*) constituting merely a fluid matrix such as that described for *Luzula*[2], the first plant organism specifically stated to possess diffuse centromeres. In *Spirogyra*, this substance becomes more or less deposited on the chromosomes during anaphase[3] and removed during telophase. In some species, globules of the substance proceed to the poles independently of the chromosomes.

This substance was called 'nucleolar-substance' by Geitler, and the name may prove to be a truly descriptive one. However, my own observations have shown, so far, that the nucleolus of the resting stage has always become completely broken down at metaphase; the stages of its breakdown, a lengthy process, are readily observable. The organisation of new nucleoli in telophase can also be followed from the earliest stages. It is therefore clear that the 'nucleolar substance' present at metaphase is not part of the nucleolus proper.

There is no evidence, as yet, of the chemical nature of the 'nucleolar substance', though this is being sought. The staining reactions so far as observed do not differ from those of the nucleolus.

A cyto-taxonomic survey of the species of *Spirogyra* and other Conjugales has been begun in this Department. It is apparent that the species are well differentiated by the numbers and characters of their chromosomes.

It may well be that we have in *Spirogyra*, as in other lowly organisms, access to evidence which may eventually make it possible to distinguish chromosomes of different kinds. That some will be called 'primitive' and others 'advanced' is inevitable. It may be pointed out that the idea is an old one, discussed by Geitler[3].

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Basal Sterility in Wheat

THE wheat spike is an example of the occurrence of parallel development of morphologically similar structures, namely, the spikelets and florets. The spike consists of an axis upon which are arranged two opposite rows of spikelets. Each spikelet consists of an axis upon which are arranged two rows of florets. The apical and basal spikelets are often sterile, and in each spikelet the third floret (counting from the base) is often sterile and the fourth floret usually sterile. Apart from these differences, the spikelets and florets are indistinguishable at maturity. This similarity emphasizes the interest of the action of the 'sterile base' genotypes[1] which condition a sterility of the basal floret of each spikelet. Three types are known: St_1, in which the basal (first) florets are sterile; St_2, in which the basal and second florets are sterile; and St_3, in which the basal, second and third florets are sterile. Only the St_1 type has

been studied in any detail. The St_F (basally fertile) type when crossed with the St_1 type gives in the F_2 a range of sterility/fertility from completely basally fertile to completely basally sterile. The intermediate types, in which some spikelets are basally fertile and some basally sterile in the same spike, are termed St_i.

The restriction of gene action is apparently determined by an intra-spikelet mechanism, since in the St_i type basally sterile spikelets occur at random along the spike. This indicates that the basal fertility/sterility of each spikelet is independent of the others.

The basal sterility appears to be an abortion of the growth of differentiated floral primordia, since in young St_1 spikes[1] all stages of absence of floral organs were found in the basal floret, from complete absence of floral parts to complete presence. The frequency of absence differed between floral parts, and is related to their sequence of differentiation[2]. The first differentiated parts, the anthers and palea, are more affected than the pistil, which is the last part to be differentiated. The floret consists of a bract, the lemma, which encloses the three anthers, the pistil, and the palea, which is a membranous leaf. The lemma is very similar to another bract, the glume, which occurs at the base of the spikelet. The 'sterile base' genes affect only the anthers, palea and pistil, having no macroscopical effect upon the lemma or glume. These genes therefore define two developmental sequences: the 'true' floral sequence which is affected by the *St* genes, and the 'vegetative' floral sequence which is not affected by the *St* genes.

A hypothesis can be formulated which explains most of these facts, without including a concept of the different florets along a spikelet differing in their primary sequence of development, differences between florets being due only to time of development. It is necessary to postulate: (1) that an activator (evocator, hormone) exists which controls the growth of differentiated floral primordia, (2) that this activator only has an effect when its concentration exceeds a certain threshold level, (3) that the different florets are sensitive (competent) to react to this activator only during a certain period, (4) that the activator has only a short radius of action, and is separately formed within each spikelet.

A diagram representing the development of a typical spikelet is shown in Fig. 1. The 'sensitive periods' of each floret are shown on the horizontal scale, with the sequence anthers, palea and pistil. The concentration of the activator is shown vertically, with the threshold level of its action. If the concentration of the activator exceeds the threshold level at a sensitive period, then that floret grows. If the concentration is just below the threshold-level,

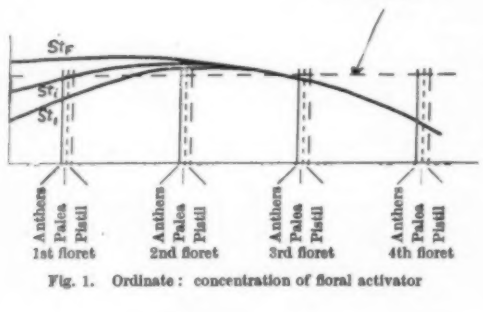

Fig. 1. Ordinate: concentration of floral activator

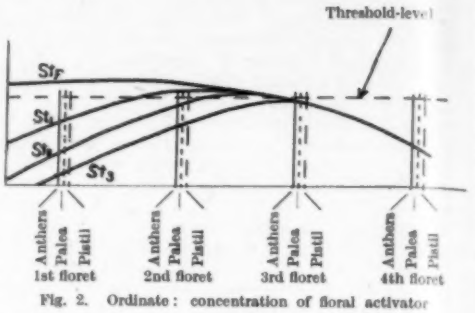

Fig. 2. Ordinate: concentration of floral activator

or differs between parts of a floret, then the proportion of florets which grow is defined by the deviation of the actual concentration of activator below the threshold. Into this model are interpolated three curves of the relation of the concentration of the activator to the degree of spikelet development. These three curves represent spikelets of the St_F-, St_i- and St_1-types respectively. Similarly, in Fig. 2 are shown four curves representing the St_F-, St_i-, St_2- and St_3-types respectively. It can be seen how, on this model, the restriction of the effect to the first floret, the differences in frequency of abortion between the floral parts, and the similarity of mutant sterility of the basal floret to the normal sterility of the third and fourth apical florets, are all integrated.

The formulation of hypothetical models can have little purpose other than the efficient planning of future work. The above model is proposed for such a purpose.

A. Stewart Fraser*

Wheat Research Institute,
Christchurch,
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Nov. 21.

* Now at the Institute of Animal Genetics, Edinburgh.

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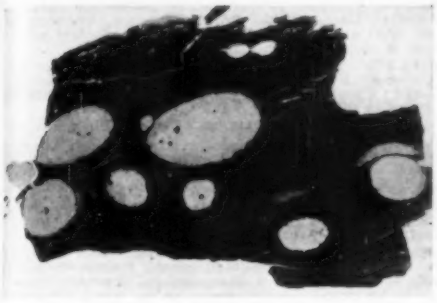
[2] Bonnet, O. J., *J. Agric. Res.*, **53**, 445 (1939).

Occurrence of Fossil Resins in the Oil-Shales of the Punjab Saline Series

In a recent discussion[1] on the age of the Saline series, Dr. E. R. Gee disputes Prof. B. Sahni's evidence of micro-fossils for an Eocene age[2] on two grounds: first, the discovery by Messrs. Ghosh, Sen and Bose[3] of similar post-Palæozoic micro-fossils in overlying beds of undoubted Cambrian age shows that Prof. B. Sahni's fossils are exotic in origin and of no stratigraphical significance; and secondly, the contact between the Saline series and the overlying Talchirs in the western parts of the Range is a normal sedimentary overlap and, therefore, the Saline series must be pre-Talchir in age. Dr. Gee further states: "It is considered that the Saline series of the Salt range, together with the overlying higher Cambrian, was deposited in the coastal waters of the Vindhyan sea which, prior to the formation of the Gondwana... flooded the region from the south". In the present communication, attention is directed to the presence of fossil resins in the oil-shales of the Saline series, and it is pointed out that, as resin-bearing plants are unknown from strata older than the Carboniferous, a Cambrian age for the Saline series is untenable. It is further noted that the late pre-Cambrian (or possibly



Thin section of oil-shale from near Ratta (Salt Range) showing resins. × 3

Cambrian) coal found interbedded with the Vindhyan limestones is algal in nature, and does not show any evidence of being derived from vascular plants as is the case in the Punjab oil-shales.

Bituminous oil-shales are found interbedded with the upper and lower gypsum – dolomite stages of the Saline series in several localities, and microscopic examination of numerous thin sections has shown that resins are invariably present though in minute quantities. Oil-shales from near Ratta, in the Chittidil area, however, show a rich concentration of resin bodies often exceeding 1 cm. in length. The Ratta samples come from a section which Dr. Gee has regarded as critical evidence for his overlap theory, and the sequence as noted by him is as follows :

Talchir boulder-bed
—undisturbed sedimentary contact—
Upper Gypsum – Dolomite stage of the Saline series with bands of cherts and cherty dolomites alternating with kerogen shales in the upper part.

A thin section of the oil-shale mentioned in the above sequence is shown in the accompanying photograph. The ovoid resin bodies are transparent, pale golden-yellow in colour and lie with their long axes nearly parallel to one another and to the lamination of the shale. The resins contain some brown, highly decomposed plant tissues and also microscopic crystals of pyrites and air-bubbles. No recognizable organic remains were found. It is difficult to conceive that the resins are derived from any source other than the vegetation which has given rise to the oil-shales.

No pre-Carboniferous fossil resins seem to have been hitherto recognized. David White[4] proved that resins are present in Carboniferous coals of a somewhat low bituminous rank. According to Sir Cyril Fox[5], Indian Gondwana (Middle to Upper Permian) and Jurassic coals contain no resin ; I have, however, noticed resins in a carbonaceous shale from the Middle Productus limestones (Late Permian) of the Nammal gorge (in the western part of the Salt Range). Thiessen[6] makes the observation that all coals from Carboniferous to Cretaceous have been derived largely from conifers which were probably the chief source of resins in coals of these ages. A few occurrences of coal of Devonian age are known but they are non-resinous ; nor do we find any mention of secretory cells or strands in well-preserved Devonian plants.

Since Dr. Gee has suggested a Vindhyan age for the Saline series, a brief reference may be made to the coal which occurs as lenticles in the Vindhyan limestones. Thin sections of this coal (which is being investigated by my colleague Dr. R. C. Misra[7]) do not show any evidence of vascular plants ; that it probably owed its origin to marine algæ is demonstrated by the discovery of a primitive *Dasycladacea* allied to the Ordovician genus *Cœlosphæridium* in it. Further evidence of its algal origin is furnished by dusky patches of calcium carbonate similar to the 'algal dust' which Dr. Alan Wood[8] has described from the Lower Carboniferous limestones of England. It is obvious that the Vindhyan coal and the Punjab oil-shales are derived from totally different types of vegetation, and there is no evidence to suggest that the two are contemporaneous.

S. R. Narayana Rao

Geology Department,
University of Lucknow.
Dec. 3.

[1] Gee, E. R., *Abstr. Proc. Geol. Soc., London*, No. 1453 (1949).
[2] Sahni, B., *Proc. Nat. Acad. Sci., Allahabad*, **16** (1946).
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[4] White, D., *U.S. Geol. Surv.*, Prof. Paper No. 85 (1914).
[5] Fox, C. S., *Mem. Geol. Surv. Ind.*, **57**, 73 (1931).
[6] Cited by Moore, E. S., "Coal", 173 (1947).
[7] Misra, R. C., *Curr. Sci.*, **18**, No. 12 (1949).
[8] Wood, A., *Geol. Mag.*, **78**, 192 (1941).

An Unusual *Rh* Chromosome Combination

What must be an extremely rare *Rh* chromosome, C^wD^ue, has been recognized in a person whose genotype is C^wD^ue/cde.

The C^w gene, which is allelomorphic to C and c, has a frequency in English people of 1·29 per cent[1] ; it has been identified in the combination C^wDe and C^wde[2]. The equivalent antigen is demonstrated by the use of a pure anti-C^w serum, of which several examples have now been found.

The gene D^u, an allelomorph of D and d[3], occurs in the combinations CD^ue, cD^uE and cD^ue, with a frequency not yet precisely determined but which probably does not exceed 1 per cent of English blood samples. No pure anti-D^u-serum has yet been found. D^ud red cells are recognized by their giving some, but not all, of the reactions expected of D ; the reason for this is that some sera are anti-D in specificity, others anti-D + D^u. There appear to be many slight, but heritable, variations of D^u.

The proposita and two of her cousins are of the genotype C^wD^ue/cde ; and, in conformity with previous experience[4], the grade of D^u is the same in all three members of the family. The mother of the proposita is of the genotype C^wD^ue/CDe, and the maternal aunt C^wD^ue/cDE : the presence of D^u in these two people has to be assumed from the pedigree evidence, for the antigen is masked, serologically, by the accompanying D.

That C^wD^ue should exist follows as a consequence of Fisher's demonstration of the three series of allelomorphic antigens ; its identification in this family provides yet further—though now almost superfluous—evidence for the correctness of Fisher's views.

The readiness of the family to co-operate in the investigation is very much appreciated.

Ruth Sanger

Red Cross Blood Transfusion Service,
Sydney, New South Wales.
Dec. 12.

[1] Race, R. R., Mourant, A. E., Lawler, Sylvia D., and Sanger, Ruth, *Blood: the Journal of Hematology*, **3**, 689 (1948).
[2] Callender, Sheila and Race, R. R., *Ann. Eugen.*, **13**, 102 (1946).
[3] Stratton, F., *Nature*, **158**, 25 (1946).
[4] Race, R. R., Sanger, Ruth, and Lawler, Sylvia D., *Nature*, **162**, 292 (1948).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, April 24

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Mr. M. Beresford: "Lost Mediæval Villages".

Tuesday, April 25

PHYSICAL SOCIETY, ACOUSTICS GROUP (at the National Hospital, Queen Square, London, W.C.1), at 3 p.m.—Discussion on "The Technique of Subjective Measurements" (to be opened by Dr. D. B. Fry).

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Miss Sona Rosa Burstein: "Field-Work in Old-Age Study".

ROYAL SOCIETY OF ARTS, DOMINIONS AND COLONIES SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. W. V. Blewett: "Agricultural Development in Tropical Africa".

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. M. M. Hallett: "Corrosion Resisting Cast Alloys containing Nickel, Chromium and Molybdenum".

Tuesday, April 25—Friday, April 28

INSTITUTE OF WELDING (at Birmingham).—Conference of Branch Officers and Spring Meeting.

Wednesday, April 26

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (joint meeting with the ROYAL SANITARY INSTITUTE, in the Winter Garden Pavilion, Devonshire Park, Eastbourne), at 10 a.m.—Discussion on "Hygiene and Food Manufacture".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. M. Du-Plat-Taylor: "Coast Protection and the Reclamation of Land from the Sea".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Annual General Meeting; Prof. C. E. Tilley, F.R.S.: "Some Aspects of Magmatic Evolution" (Presidential Address).

PHYSICAL SOCIETY, COLOUR GROUP (in the Lecture Room, Institute of Ophthalmology, Judd Street, London, W.C.1), at 3.30 p.m.—Prof. R. A. Morton, F.R.S.: "Recent Work on Chemistry in relation to Vision".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.1), at 5.15 p.m.—Mr. F. A. A. Menzler: "London and its Transport System".

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. E. Bonwitt and Mr. H. E. Charlton: "The Fuel, Heat and Power Aspects of the Petroleum Chemicals Plant for Petrochemicals, Ltd., Partington".*

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, CHEMICAL SECTION (at the Portico Library, Mosley Street, Manchester), at 5.45 p.m.—Dr. H. Gudgeon: "Some Aspects of Industrial Chemical Research".

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL of the FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.15 p.m.—Dr. F. Wokes: "The Nutritional Significance of Vegetarianism".

WOMEN'S ENGINEERING SOCIETY, MANCHESTER BRANCH (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. J. N. Hardwich: "Electrical Insulating Materials".

CHEMICAL SOCIETY, SOUTHAMPTON SECTION (joint meeting with the MID-SOUTHERN COUNTIES SECTION of the ROYAL INSTITUTE OF CHEMISTRY and PORTSMOUTH AND DISTRICT CHEMICAL SOCIETY, at the Municipal College, Portsmouth), at 7 p.m.—Dr. W. A. Roach: "Trace Elements in Plant Life".

Wednesday, April 26—Thursday, April 27

IRON AND STEEL INSTITUTE (at 4 Grosvenor Gardens, London, S.W.1), at 10 a.m. each day.

Wednesday, April 26

At 11 a.m.—Mr. J. R. Menzies-Wilson: Presidential Address; at 8.30 p.m.—Mr. James Mitchell: "Centenary of the Birth of Sidney Gilchrist Thomas".

Thursday, April 27

INSTITUTE OF FUEL (at the Connaught Rooms, Great Queen Street, London, W.C.2), at 11 a.m.—Annual General Meeting; Dr. D. T. A. Townend: Second Presidential Address.

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. H. D. Kay, F.R.S.: "The National Institute for Research in Dairying".

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

CHEMICAL SOCIETY, SHEFFIELD SECTION (joint meeting with the UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Lecture Theatre, The University, Sheffield), at 5.30 p.m.—Prof. F. S. Spring: "Recent Advances in the Chemistry of the Steroids" (Tilden Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. D. W. Fry, Mr. J. Dain, Mr. H. H. H. Watson and Mr. H. E. Payne: "The Design and Operation of a 30-MeV. Synchrotron"; Mr. F. K. Goward, Mr. J. D. Lawson, Mr. J. J. Wilkins and Mr. R. Carruthers: "The Design of Electron Synchrotrons".

SOCIETY OF CHEMICAL INDUSTRY, CROP PROTECTION PANEL of the AGRICULTURE GROUP (at the Royal Institution, Albemarle Street, London, W.1), at 6 p.m.—Dr. Hubert Martin: "Advances in Chemical Methods of Crop Protection" (Inaugural Meeting).

ROYAL AERONAUTICAL SOCIETY (in the Chemistry Lecture Theatre, The University, Manchester), at 6.30 p.m.—Mr. J. A. Beavan and Mr. D. Holder: "Recent Developments in High Speed Research in the Aerodynamics Division of the N.P.L.".

ROYAL GEOGRAPHICAL SOCIETY (at the Science Museum, Exhibition Road, London, S.W.7), at 7.15 p.m.—Mr. E. A. Miskin: "Modern Methods of Precision Measurement using Photographic Techniques".

Friday, April 28

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Geophysical Discussion of Papers received during the Session.

ROYAL STATISTICAL SOCIETY, SOUTH WALES GROUP of the INDUSTRIAL APPLICATIONS SECTION (at University College, Cathays Park, Cardiff), at 7 p.m.—Mr. T. A. Humphreys: "Sequential Tests".

SOCIETY OF DYERS AND COLOURISTS (at the Midland Hotel, Bradford), at 7.15 p.m.—Dr. A. B. Meggy: "Some Recent Developments in the Theory of Dyeing" (Seventh Mercer Lecture).*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT ADVISER (Grade III) IN HORTICULTURE—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (April 29).

LECTURER IN CHEMISTRY—The Principal, North Staffordshire Technical College, Stoke-on-Trent (April 29).

SEED ANALYST in the Branch of Botany and Plant Pathology of the DEPARTMENT OF AGRICULTURE AND LANDS, and a GEOLOGIST in the DEPARTMENT OF GEOLOGICAL SURVEY, Southern Rhodesia—The Secretary to the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (April 29).

SENIOR ASSISTANT IN BIOLOGY, a SENIOR ASSISTANT IN CHEMISTRY, a LECTURER IN BOTANY, a LECTURER IN GENERAL BIOLOGY, a LECTURER IN MATHEMATICS, and a LECTURER IN PHYSICS—The Principal, Acton Technical College, High Street, Acton, London, W.3 (April 29).

ASSISTANT LECTURER IN THE DEPARTMENT OF APPLIED MATHEMATICS—The Registrar, The University, Liverpool (May 1).

BIOCHEMIST (ranking as a Lecturer in the Department of Clinical Chemistry, University of Edinburgh) to take charge of the biochemical routine work and to engage in research at the Bangour Hospital—The Secretary, The University, Old College, Edinburgh (May 1).

LECTURER or ASSISTANT LECTURER IN PHYSICS—The Registrar, University College, Exeter (May 1).

PRINCIPAL OF ENFIELD TECHNICAL COLLEGE—The Chief Education Officer (F/CW), 10 Great George Street, London, S.W.1 (May 1).

TECHNICAL OFFICER to supervise experiments mainly in woollen mills—The Secretary, Wool Industries Research Association, Torridon, Headingley, Leeds 6 (May 6).

UNIVERSITY DEMONSTRATOR IN AGRICULTURAL ENTOMOLOGY—The Secretary, School of Agriculture, Cambridge (May 10).

SENIOR LECTURER IN MATHEMATICS (Statistics), and a SENIOR LECTURER IN APPLIED MATHEMATICS, at the University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 15).

SENIOR SOIL SURVEY OFFICER (B.W.I. Soils Research Scheme), a SENIOR SOIL SCIENTIST (B.W.I. Cocoa Research Scheme), SOIL SURVEYORS for B.W.I. Soil Survey, a SOIL CHEMIST for general fertility studies, a SOIL PHYSICIST for studies of soil-moisture relationships with rainfall and general meteorological conditions, a CHEMIST/SPECTROGRAPHER, and a BIOCHEMIST for biochemical studies of cacao with special reference to fermentation of cocoa beans and quality, at the Imperial College of Tropical Agriculture, Trinidad—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (Trinidad, May 24).

BOTANIST (Senior Scientific Officer grade) for a Tsetse Fly Survey in Nyasaland to carry out a study of the botanical side of ecology of tsetse fly in conjunction with the Tsetse Entomologist—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1.

DIRECTOR OF THE AGRICULTURAL EXPERIMENTAL STATION, Mount Edgecombe, Natal—The Secretary, South African Sugar Association, P.O. Box 507, Durban, South Africa.

ENGINEER (fully qualified, with some years' industrial experience) for new post of Tutor in Industrial Design and Techniques in the School of Wood, Metals and Plastics—The Registrar, Royal College of Art, South Kensington, London, S.W.7.

EXPERIMENTAL OFFICER (female preferred, with qualifications in chemistry and biology) IN THE DEPARTMENT OF INSECTICIDES AND FUNGICIDES—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

LECTURER IN HORTICULTURE (with special reference to pomology and fruit growing), an ASSISTANT AGRICULTURAL ECONOMIST, and a DEMONSTRATOR (with a degree in horticulture or equivalent) IN THE DECORATIVE SECTION OF THE DEPARTMENT OF HORTICULTURE—The Registrar, Wye College, Wye, Ashford, Kent.

PRINCIPAL, a SENIOR LECTURER IN ANTHROPOLOGY, a LECTURER IN ANTHROPOLOGY, a SENIOR LECTURER IN NATIVE EDUCATION, a SENIOR LECTURER IN COLONIAL ADMINISTRATION, a LECTURER IN GEOGRAPHY AND LAND UTILIZATION, and a LECTURER IN LINGUISTICS, at the Australian School of Pacific Administration, Sydney, N.S.W.—The Official Secretary, Office of the High Commissioner for Australia, Australia House, London, W.C.2, endorsed 'Department of External Territories, Canberra'.